SCIENTIFIC AMERICAN SUPPLEMENT. No. 1301

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Scientific American, established 1845.
Scientific American Supplement, Vol. L, No. 1301. NEW YORK, DECEMBER 8, 1900. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

PAVILION OF BOSNIA-HERZEGOVINA AT THE PARIS EXPOSITION.

IN the series of national pavilions is that of Bosnia-Herzegovina which is represented in the illustration. It shows the recent development of this country, which forms part of the Austro-Hungarian empire, and the exhibits it contains illustrate not only the history of the country, but the progress which is being made in the arts and industries, agriculture, education, railroads, etc. The building has been designed by the architect, M. Joseph Markovic. It is somewhat of an Oriental character, but contains many diverse elements. The square tower represents one of the older constructions designed as a means of defense, and the rest of the building is an ensemble of the various architectural types which prevail in the region. The interior contains a high central hall, lighted from the roof. It is surrounded above and below by a series of galleries, which contain a large part of the exhibits. At the top is a frieze executed by Mucha, who, although reckoned among the French artists, is of Slavonic origin; it represents a series of characteristic scenes. In the corners are two horsemen in armor, one of whom is shown in the illustration. In the center of the main hall is a large diorama representing a market scene in the city of Serajevo, the capital of the country. In front of it are displayed a great number of fine rugs of Oriental design, and on each side are a number of looms to show the weaving processes. This industry is now being encouraged by the government, which has founded a model workshop and training school in connection with the museum of Sarajevo. Two of the pupils of this school, who have become skilled workers, are shown in native costume in one of the illustrations. The industry will have an important market at Vienna and Berlin, and is already making rapid progress. The art industries, whose main schools are at Sarajevo, are represented by a number of collections of porcelain, glass, inlaid and incrusted metal work of high artistic value, etc. The tissues and embroideries executed at the government workshops are especially fine.

BOSNIAN WOMEN EMBROIDERING.

A number of collections have been sent by the different archæological stations, representing objects of different periods found in the tombs and excavations. These collections occupy a number of cases; among the great variety of objects may be mentioned a series of bronze fibulæ found at the necropolis of Glasniac, and a number of bronze sickles and other implements. The neolithic station of Boutmir has contributed many interesting pieces, including a number of idols, iron daggers, bronze casques in the Etruscan and Corinthian styles, etc. A number of bronze fibulæ come from the necropolis of Gorica, and a highly ornamental set in embossed silver from Strbei, besides many bronze vases and pieces of pottery. Two large Roman mosaics, one of them containing portraits, are also to be seen. A number of trophies represent arms and armor of the middle ages, and some finely embroidered garments are shown.

Near this collection is a model representing an assemblage of farm buildings, showing the construction of the dwelling house and outbuildings, with a primitive water-mill; the farm implements are also shown in miniature. One of the rooms of the building has been fitted up to show the interior of a harem. The walls are of carved or painted wood, and the room contains a number of figures representing the

PAVILION OF BOSNIA-HERZEGOVINA AT THE PARIS EXPOSITION.

AGRICULTURAL EXHIBIT OF BOSNIA AT THE PARIS EXPOSITION.

native costumes, besides the furniture and household articles.

The upper part of the building contains a number of collections representing the various public works, railroads, the development of agriculture, educational systems, etc. A number of specimens of carved woodwork, such as is used in domestic architecture, are of interest; besides, the front of a small dwelling house is shown in full size, with a shop in the lower part, in which a shoemaker sells his wares. A staircase leads to the upper room, which has a porch at the side in ornamental woodwork. The collection includes a number of maps and hydrographic charts. The state railroad system is represented by a fine collection of transparencies showing picturesque views along the different routes, and a full-size reproduction of a sleeping-car section is to be seen. The products of the country are well displayed; among the principal of these are wool, silks, wines, tobacco, honey, etc. The government agricultural stations have sent collections of the grains found in different parts of the country, and have arranged a pyramid of grain specimens, showing the cultivation at different heights above the sea level, ranging from 300 to 4,200 feet. Prunes form one of the staple products of the country and are well represented, as well as bee-hives, honey, and beeswax.

AMERICAN MACHINERY BUILDING AT VINCENNES.

As all the American machinery exhibits could not be contained in the space allotted for this purpose in the Champ de Mars buildings, a special building was

BOSNIAN HORSEMAN AND PART OF FRIEZE BY MUCHA.

erected at the Vincennes Annex, in which most of the leading American firms were represented; the greater number of these had also exhibits at the main part of the Exposition. The building was erected by the Berlin Iron Bridge Company, the skeleton frame being overlain with white staff. The building is about 350 feet long and 120 feet wide, thus affording a large floor space. In the center there was a Shaw electric traveling crane of 30 tons capacity and a 33-foot span. The machinery was operated entirely by electric motors, most of these ranging from 5 to 15 horse power. The current was supplied by a generating plant in one corner of the building; in the boiler room there were two Climax upright boilers, which supplied a Ball engine of the horizontal type, which drove a Bullock dynamo of 200 kilowatts capacity.

One of the most interesting exhibits was that of the Ingersoll-Sergeant Drill Company. It contained a cross compound Corliss engine and air compressor of a capacity of 615 cubic feet of free air per minute, and a second compressor of 382 cubic feet capacity; these compressors were used to furnish power for some of the machines which were operated by compressed air motors, and a line of 4-inch piping was laid to the Transportation building, 100 feet distant, where some of the air-brakes and signals were operated. The exhibit includes one of the large track-channelers made by the company, shown in operation. This is a machine of improved type used to cut out dimensioned stone or in canal or general excavation work where it is necessary to do a great deal of rock-cutting. In the work on the Chicago Drainage Canal thirty-five of these machines were used, giving about 160 square feet of cutting per day. The bar channeler is a smaller machine of the same type intended for marble, slate and other quarries. A number of the well-known rock drills are shown, besides a type of pneumatic coal cutter which is now largely used in the United States. Another exhibit which interested European visitors was that of the Chicago Pneumatic Tool Company. The tools for drilling, riveting, tapping, etc., were operated by small compressed air motors. The motors were contained in a cylindrical box of small size and are connected directly to the tools, thus forming a compact and portable device. The Boyer pneumatic riveter was also shown, together with samples of the work done by the different tools. In a shed outside the building was mounted a part of a skeleton iron building framework, with the riveting and drilling tools in operation to show the method.

The Bethlehem Steel Company showed its new steel turning process, which has been in practical operation in the three machine shops of the company for a little over a year. The exhibit showed a lathe driven by an electric motor turning steel with cutting speeds fully two to three times faster than before used. Three grades of steel were turned off in the lathe, with a depth of cut of $\frac{1}{16}$ inch and a feed of $\frac{1}{32}$ inch, representing the average of general practice. With this standard cut the soft steel was turned off at a speed of 150 feet per minute, and the medium and hard steel at 60 and 15 feet respectively. The cutting tools were made by a newly invented process which gives them the property of cutting at a very high working heat, and, in fact, the tool retains its cutting edge at a visible red heat, thus presenting a novel and remarkable phenomenon. The process is the invention of Messrs. F. W. Taylor and Maunsel White, employes of the company. It is stated that the average weight of metal removed per hour per tool is increased from 31·2 pounds to 137·3 pounds, showing a gain in actual work of 340 per cent. The Rand Drill Company had a large exhibit showing air-compressors and rock drills. The largest of the air-compressors has a capacity of 250 horse power. Another type of smaller size is mounted direct with a Pelton water wheel. An interesting type of air-compressor is the small upright machine with two steam and two air cylinders adopted by the United States navy for compressing air for torpedo cylinders; it gives a compression of 15,000 pounds per square inch.

The most improved types of American machine tools were well represented. The Niles-Bement-Pond Company had one of the largest exhibits of heavy machine tools, showing large engine lathes, planers, boring mills, radial drills and other machines. The Pratt & Whitney Company had also a large exhibit of machine tools. Embossing and stamping machines were shown by the E. P. Bliss and the Ferracute Machine Companies, each of which had a large exhibit of presses for brass goods, tinware, coins and badges, etc., showing samples of the work done by each. The Brown & Sharpe Company had one of the most interesting exhibits; besides the scales, rules and smaller measuring instruments, a large measuring machine was shown, which is used to determine the accuracy of standard gages and other articles which must be finished to exact size. The machine on exhibition reads to 0·0001 millimeter (0·00004 inch); it resembles a standard gage on a large scale; one point is fixed on a horizontal scale at one end of the instrument by a microscope with cross-hairs, and the reading is made by a circular scale and vernier at the other end. The company showed also a number of machine tools, such as milling machines, automatic turret machines, etc. The Norton Emery Wheel Company had a pavilion whose façade was constructed with columns formed of emery wheels; the interior contained an extensive exhibit of emery and corundum wheels, bricks and sharpening stones. One of the largest exhibits was that of the Fay & Egan Company, in which were shown the most improved types of wood-working machinery.

[Continued from SUPPLEMENT, No. 1300, page 20093.]

HIGH-WATER PROTECTION METHODS ON LOWER MISSISSIPPI RIVER.*

By WILLIAM JOSEPH HARDEE, Member American Society Civil Engineers; Member Louisiana Engineering Society.

As dollies have not been extensively used along the river, a brief description of them is pertinent. A dolly is a stick of square or rectangular shaped timber of varying size and length, according to the driving power desired, near to the outer end of which, at proper working distances apart, are nailed cross-strips or hand-boards to furnish convenient grasp for raising it. The inner end rests on the ground or a platform, and is held in position by several stakes or pegs driven about it, the ground end being but slightly lower than the outer end to maintain the dolly on something like a horizontal plane. Enough men are put at the hand-boards to readily raise the outer end of the stick several feet above the object to be driven. The stick is raised and sharply let fall alternately until the object is driven to the desired depth. Great care should be observed in selecting the position for the sheet piling with reference to the location of the leak or leaks and the character of the soil composing the embankment. The very least possible penetration by the sheet piling is desirable, to reduce vibration and avoid weakening the embankment by cracking or loosening it. In dealing with soils which easily crack or loosen when penetrated, the sheet piling should never be driven into the body of the embankment. Sheet piling should also be driven in the shortest possible time.

During the flood of 1892 a crevasse was caused by inexperienced men driving sheet piling into the embankment at Tessier's Plantation, Pontchartrain District. There were three 3-inch holes in the levee at that place, discharging within a few feet of each other at the land base of the levee. These holes had existed for some years, and had been frequently observed. In those days many such leaks existed at numerous places in that levee district; a few only of them were considered to seriously menace the safety of the levee, and those few were cut out when the river was low. But the great majority were allowed to remain undisturbed. Just before the flood reached its maximum stage, some of the leaks which had been allowed to continue showed serious symptoms, and the Levee Board decided to stop all of them. In this task a number of the bridge gangs of the Yazoo and Mississippi Valley Railroad were employed. A small gang of men, without experienced direction, commenced work during the afternoon driving sheet piling into the river slope of the embankment at Tessier.

Mr. J. W. Ross, a nearby resident and ex-member of the Levee Board, has since told me that he was present during a part of the afternoon the sheet piling was being driven; that before any of the piling was driven the holes were discharging clear water, free of sediment, and that the holes gave no evidence that enlargement was in progress; but that after a few planks had been driven the holes commenced to discharge muddy water and large quantities of sediment. There was no relief gang, and work was discontinued at nightfall, at which time some six or eight pieces of plank had been driven. At about nine o'clock that night the levee collapsed, and the river poured through the opening. There is scarcely a doubt that the piling cracked and loosened the earth in the embankment, causing it to erode rapidly, and that the sheet piling was the direct cause of the failure of the levee.

Another but more costly method for stopping leaks having their intake ends on the front slope of the levee or within reasonable working distance of the base of the levee, is to drive vertically two lines of 1 by 12-inch boards, not necessarily arranged to make close joints, from 3 to 6 feet apart (distance regulated by height of structure), with just enough penetration to furnish good toe hold, sufficiently braced longitudinally and laterally to afford required rigidity. This structure is built in a continuous length from the levee to a point beyond the intakes and back to the levee, and, after the woodwork has been completed, the interior formed by the two lines of plank is filled with earth. The structure is commonly called a mud box. Sometimes, owing to scarcity of materials or to inexperience of those doing the work, a single line of 1-inch plank was driven, and the entire space between it and the levee was filled with loose earth or sacks filled with earth. This form of structure is called a bulkhead. It is manifest that either bulkheads or mud boxes, like sheet piling, are worthless unless the sore itself, the intake end of the hole, is reached and covered. The writer has seen a large amount of all three of the kinds of work described which failed to accomplish any good.

Of the three methods named, sheet piling, when practicable, is recommended. It is equally effective, less expensive, and most quickly put in place.

When a hole develops serious symptoms and its intake end cannot be located, it must be treated in the most substantial manner possible at the discharge end.

During the flood of 1890 the writer experimented with light sheet iron cylinders of different lengths, having a diameter varying from 10 to 18 inches; they were equipped with soldered handles at intervals to afford good hand hold. To reinforce the cylinders at the base about ten cubic yards of earth was piled in conical shape about the hole, a small drain being left temporarily to take off the water flowing through the hole in the levee. As soon as the earth was in place, the iron cylinder was clapped over the hole and forced into

* Read before the Louisiana Engineering Society at adjourned regular meeting, June 18, 1900.

the ground by the weight of as many men as could get hand hold. The surrounding earth was simultaneously tamped about the cylinder. Not more than two out of a dozen of the cylinders proved successful; none of the large ones, over large holes, were successful. The water at first rose rapidly in the cylinders, but gradually diminished in rate until it stopped rising altogether. Generally the water found a line of less resistance, and broke out through the ground only a few feet away.

The common method of treating a leak at its discharge end is by building what is locally termed a "horseshoe," which is nothing more than a mud box, such as has been already described, built on the land side of the levee, and of such length as may be necessary to leave a good margin of ground on all sides of the leak. While it is expensive, this method is certain in its results if the levee is not too largely infested with leaks, and is recommended in cases of serious leaks when the intake end cannot be definitely located. In the past, when lumber was not available and sacks were at hand, "horseshoes" were constructed by pyramiding sacks filled with earth. Such a structure is unnecessarily expensive, and should be discountenanced.

During some of the past floods the writer has known short lengths of levee to be so infested with leaks that application of all the several remedial measures which have been mentioned did not assure the safety of the levee. In such cases collapse was anticipated, and, to provide against disaster, several lines of cribs (the number of lines being regulated by the depth of the water in which the structure was placed) were built and filled with sacks filled with earth. In other words, the crevasse was closed before it occurred. The cribs were so placed as to extend well beyond the base of the levee and at both ends to join sound embankment.

These very bad places were the result of neglect; of failure, when the river was low, to cut out leaks which were known to exist, but which were allowed year by year to extend and enlarge until the levee became thoroughly rotten and scarcely more water-tight than a sieve.

The improved condition of the levee line and the attention which is now usually devoted annually to repairs and maintenance warrant the belief that such extreme cases of bad levee as have just been described are things of the past.

The treatment of leaks should in the future be more simple and at the same time less expensive than in the past. To-day much more is known of their character and how to deal with them; and the best remedy only of the past should be applied until some more successful remedy is evolved. It is contemplated, of course, that none but experienced men will direct the work, and that suitable materials with which to do the work properly and economically will at all times be at hand.

The foregoing remarks refer to leaks of an ordinary character, but as very extraordinary leaks sometimes occur, it is thought advisable to describe one that came within the writer's experience and how it was treated, as under similar circumstances the same treatment would seem to be the best and should be applied. The following is quoted from my report of the 1897 flood:

"During the morning of April 27, when the water was at 52 on the Vicksburg gage, a large leak developed under the Clagget levee (644-R). At this place both the levee and surrounding soil are light loam. In the rear of the levee within 30 feet of its base there is an old burrow pit about 8 feet deep with almost vertical side next to the levee. Without previous warning a 6-inch stream of water spurted out of the wall of the pit midway its height; it did not merely run out and trickle down, but shot out as if ejected from a hose. Its force was so great as to churn the water into foam in the pit into which it was discharged. There are many theories as to the origin of this leak, but its cause will never be known unless the embankment should be cut and the hole traced.

"It is more than likely a series of disconnected holes or small cavities existed under the levee, due either to burrowing animals or decayed vegetation, or probably both, and under the pressure of water there was leakage from one to another, attended with a certain amount of wash which continued until the several holes were connected and made a free passage for the water through one large channel, where the water burst out as described.

"A large force was immediately summoned, and a semicircular wall of sacks built about 6 feet high around the discharge end. The interior space rapidly filled, and the sacks were soon overtopped. In the meantime a large force of teams was put to work, and a run-around commenced about 100 feet in rear of the main levee and designed to be about 250 feet long when completed. An opening was left in it as an outlet for the overflow until the new embankment was thought sufficiently high with proper cross-section to hold the filled basin, then the opening was closed. The basin filled rapidly at first, then more slowly; at the end of two days it was found that the basin was still filling, and would overtop the run-around. The teams resumed work, and the embankment was raised 3 feet. The basin continued to fill, but as the river commenced falling in a few days, further raising was not necessary. It now stands with an 8-foot crown, about 2 to 1-inch side slopes, and a grade about 3 feet lower than the highest point reached by the river."

SLOUGHING.

When water has stood against an earthen embankment for a sufficient time to saturate it, there is always considerable seepage caused by the river water percolating through the pores or interstices of the embankment. The amount of seepage is usually governed by the porosity of the soil composing the embankment. Seepage is not usually free in embankments composed of clayey materials; when seepage does seem to exist in them to a considerable extent, it is more properly leakage due to cracks in the embankment caused by contraction in drying out or to unequal shrinkage. Seepage is freest in embankments composed of sandy soils; the coarser the grain of sand the freer the seepage, because the soil does not become sufficiently compacted during the time the embankment is constructing to render the mass impervious to water. Voids are of large or small size, depending on the coarseness of the grains of sand. Under water pressure the voids soon become connected and form numerous minute channels, which wash and enlarge as the flood is prolonged or the pressure increased by greater height.

Seepage produces a general softening or rotting of the land slope of the embankment. The soil at this point often becomes semi-fluid, and, if the slope be steep, a part of the embankment will slough or slide out, producing a corresponding loss of cross-section. The writer has never known a first slough to extend higher up than one-half of the slope of the levee. If the seepage be not stopped, a second slough will occur higher up as soon as the face made by the first slough has been reduced to a semi-fluid condition; this action will progress in steps until the embankment has sloughed across its entire cross-section as far as the water. Its action being progressive, sloughing does not constitute an element of great danger, for there is always ample time to stop it; treatment is simple if the principles involved be understood.

To arrest sloughing, good land-side drainage and stoppage of the seepage are essential. A competent drain ditch should be cut, about 2 feet clear of the base of the levee, to conduct the seepage water as frequently as possible to some natural line of drainage in the rear of the levee. Additionally, numerous small V-shaped gullies, an inch or so only wide and deep, should be cut in the land slope of the levee to promptly deliver the seepage water to the drain ditch. The position and size of the drain ditch and gullies should be such as to assure the removal of the seepage water as fast as it comes through the embankment, for if this water is not allowed to stand, the land slope will not become water-soaked and its integrity will be preserved.

The next step is to stop the seepage; this is effected by dumping loose earth into the water in sufficient quantity to cover the submerged front slope with a blanket of fresh soil several inches thick, the coarser particles of which will be sucked into the interstices or small channels. These soon expand from wetting, and shortly the seepage will be "choked." The layman who sees this work in progress will immediately classify dumping loose earth in the water as sheer nonsense, but, as a matter of fact, the good effect will manifest itself in a short while after work has been commenced; at first by reduced seepage, a little later by entire stoppage, and ultimately by the mass drying out and showing no further inclination to move.

If sloughs be treated when they first occur, or, better still, before they occur, when their approaching occurrence is clearly indicated to the experienced eye by the presence of excessive moisture on the land slope, much annoyance and expense can be avoided. As the treatment of sloughs is necessarily expensive when a number occur in close proximity and the supply of labor is limited, they may be only partially instead of wholly treated; that is, in lieu of putting a large enough blanket of loose earth on the river slope of the levee to provide against further seepage during the entire flood period, only a small blanket need be put on, just enough to stop the seepage for a few days. The wheeling runs should be left in position, and, as soon as seepage again manifests itself, work should be resumed until the flow is once more stopped. In this way a force of fifteen to twenty men may be kept nearly constantly employed working from slough to slough.

It is usually the case, when a slough occurs and an inexperienced man tries to correct it, that he will endeavor to restore the lost cross-section with earth or sacks. This does no good, but rather tends to augment the trouble, because the slough is thereby rendered more difficult to drain, and at the same time that much more weight is put on the semi-fluid mass to squash it out, which invariably pulls with it some of the remaining good embankment. He does this because he does not understand what produces the slough. He does not know that it is caused by too free leakage through the embankment and inefficient land-side drainage.

The writer received his first lesson in treating sloughs by observing men at work about a fleet of coal barges. If a barge starts a seam leak, it is impracticable to dig away the coal to get at it. It is equally impracticable to detect the leak by feeling along the outer or water side of the barge, as the inflow is too light to be detected by the hand, and then, again, as a loaded barge draws from 8 to 9 feet of water, it would oftentimes be impossible to reach the leak by hand. But the coal barge man has a supply of coarse sawdust, and by means of a long handle, to which it is attached, lowers a cup of sawdust in the water within close proximity to the leak, shakes it gently, just next to the barge, and, as the sawdust floats out of the cup, some of it is drawn into the crack and becomes lodged; it very shortly gets wet and swells, and the leak is choked. The same principle applies to stopping sloughs.

SINKING.

Sinking embankment is treacherous and requires the most careful attention and the exercise of good judgment in its treatment to prevent disaster. It is treacherous because its action is sudden and not always attended with premonitory signs, and good judgment must be exercised in treating it, lest the remedial measures prove destructive. A troublesome feature which attends the care of a sinking levee is that it is invariably situated in an ill-drained swamp, which soon fills up with seepage or rainwater, and earth with which to repair it is not immediately accessible, having generally to be transported a long distance on barges. At the present time there are only two lengths of sinking levee in the Fourth District. One of them, which covers about 2,000 lineal feet, is at Kempe in the Lower Tensas District, and the other, which is a small affair about 50 feet long, is at Point Manoir in the Atchafalaya District.

Several sinking levees, of greater lengths and attended by subsidence of greater extent than the two levees just mentioned, have been experienced in the past, but after much work they were made secure. The most aggravated cases of sinking seem to have a limit of subsidence, and it is only a question of continuing to pile on earth to secure a substantial embankment. The levees at Kempe and at Point Manoir should therefore be made secure in time.

A levee sinks because it is built on a foundation composed of quicksand or some other equally soft or semi-liquid material, the power of which to sustain weight is governed by the degree of moisture contained at the time the weight of the embankment is put on. It has sometimes occurred that the sustaining power has, during construction, been sufficient to support the embankment, and no movement has taken place until some later date, when the strength of the foundation has become impaired by being excessively wetted.

It has been the general experience, however, that all aggravated cases of sinking levee have been attended by considerable subsidence during construction.

As the weight of the embankment is the direct cause of the sinking, care must be observed not to add, during a flood, more earth than is actually necessary to hold the water. As the embankment subsides, the very slightest possible addition should be made to maintain an elevation several feet above the water surface and the narrowest width of cross-section that will resist seepage. This will entail almost continuous work of small amount rather than a large amount at intervals. It must not be forgotten that if a large amount of earth should be added in a short space of time, the rate of sinking will be accelerated, and the addition will do more harm than good.

Sinking embankment seldom subsides uniformly. Parts of it sink faster than others, causing the levee to crack longitudinally. There is usually one large crack along the crown of the levee, though sometimes other but smaller parallel cracks occur. Care must be taken to keep the water excluded from all or as many of the cracks as possible, particularly the largest one. As soon as water enters a crack, hydrostatic pressure is exerted on the section of embankment in the rear of the crack, and the remaining embankment in front of the crack is rendered valueless as a factor of strength in resisting the pressure of the river. For this reason the addition which is made to keep the top of the levee above the water surface should be placed as far as practicable to the water side of the crack. Lateral cracks which would let the water into the longitudinal cracks must be guarded against and immediately stopped if any occur. If, as is somewhat common, there is seepage through a sinking embankment, prompt measures must be taken to remove the seepage water in the manner described for treating sloughs. As much depends upon keeping the levee dry, it is advisable to spread tarpaulins on the entire sinking levee or at least cover the large cracks while rain is falling, to prevent wetting and to exclude rainwater from the cracks.

A sinking levee may be compared to a sick baby, and requires the same continuous attention and care. As only a small margin of safety exists, a competent force, equipped with ample materials, should be retained at the levee night and day, prepared to care for emergencies at a moment's notice.

WAVE-WASH.

Wave-wash is common on levees exposed to full wave action and not protected by a close growth of grass or some artificial device. It is a much overrated danger, and has been the cause of the needless expenditure of large sums of money in the past. Wave-wash is misleading in its appearance; in nearly every instance its worst feature is visible, but the inexperienced invariably conceive the idea that the vertical face made by the wash extends to the base of the levee and that the cross-section of the levee has been so much reduced as to seriously endanger the embankment. As a matter of fact, the deposed soil settles into position just under the water surface, and the reduction of the cross-section is no greater than is apparent above the water surface.

There was a time in the past when the cost of moving earth was comparatively high, and it was less expensive to prevent a part of the levee washing away than to allow it to wash away and afterward replace it. But this condition no longer exists; under ruling prices for moving earth it is cheaper to restore wave-wash than to prevent it with revetment. Revetment should therefore not be resorted to until the safety of the levee is endangered, which, in the writer's opinion, is not until the crown itself has been attacked. It is accordingly recommended that no steps be taken to arrest wave-wash until the vertical face it cuts has reached the river edge of the crown of the embankment.

When revetment is used, as its service will be but temporary, the most inexpensive structure should be employed. Such a structure consists of posts 3 × 3 inches or 4 × 4 inches, driven into the river slope of the levee and inclining toward the levee at an angle of 15° to 20° from vertical; the upper end of these posts should be rendered immovable by 2 × 6-inch braces connecting them with a short piece of 4 × 4 inches or 2 × 6 inches, called an "anchor," driven in the crown of the levee. The posts should be placed not more than 6 feet apart, to give the structure sufficient rigidity to resist the buffeting of the waves. To the outer face of the posts must be nailed 1 × 12 inch boards, laid horizontally, care being taken to have the bottom board everywhere throughout its length rest firmly on the slope of the embankment to prevent under-wash. It is not usually necessary to maintain the boarding higher than 2 feet above the water surface to provide against destructive overwash. If revetment be placed in the early stages of a flood, the posts should be made long enough to stand such additional plank as the rising river may afterward necessitate.

EXCESSIVE EROSION AT SALIENT ANGLES.

This is a danger which is not often encountered, and it may be easily provided against; its existence is directly due to the inexperience or inattention to duty of the constructing engineer.

Acute salient angles are rarely put in new levee lines; the most acute angles put in new levee lines are the re-entering angles. Acute salient angles in the controlling line of levee are usually found at the junction of a new levee with an old one. If such a junction occur behind a sharp point in the line of the river, it will be subjected to excessive velocity of the current. When the river is extraordinarily high, the distance across a point is so much shorter than the length of the channel around the point that the river pours across the point with increased velocity. This excessive flow should be restrained from exerting any influence on the controlling line of levee by leaving the old levee, which the new levee adjoins, undisturbed for

several hundred feet from the junction. In building new levees it is a common practice to cut away the old levee, which may be nearby, to secure better building material and at the same time to reduce the length of haul. There is generally no objection to doing this, but in cases of salient angles, which, under the circumstances above related, would be exposed to excessive wash, the practice should be omitted.

If, however, a salient angle should be washing at a dangerous rate, the wash may be arrested by constructing a wing dam to check and divert the current. A suitable and inexpensive wing dam consists of a crib similar to that described under the head of "Leaks," built at an angle of about 45° to the axis of the flow on the upper side of the salient angle. The wing dam should be commenced at a point on the levee about 50 feet above the angle, and extended so far that its outer end reaches to or overlaps the salient.

CUTTING.

Cutting a levee by malicious or insane persons can be prevented only by closely guarding the line while the water is near enough to its top to permit the work of cutting to be done in a short time. Remedial measures are of no avail; preventive measures alone must be employed.

EQUIPMENT AND ORGANIZATION.

To execute most economically, as the exigencies of the situation demand, any of the various kinds of work which have been described, suitable tools and materials and ample labor under competent direction must be at hand. As has been stated, much waste has resulted in the past from the use of other than the materials best suited, because the most suitable materials were not available, and from incompetent direction of the work. In protection work, as in other things, "a stitch in time saves nine." Much expense may often be avoided if a weakness be discovered in its incipiency and promptly corrected.

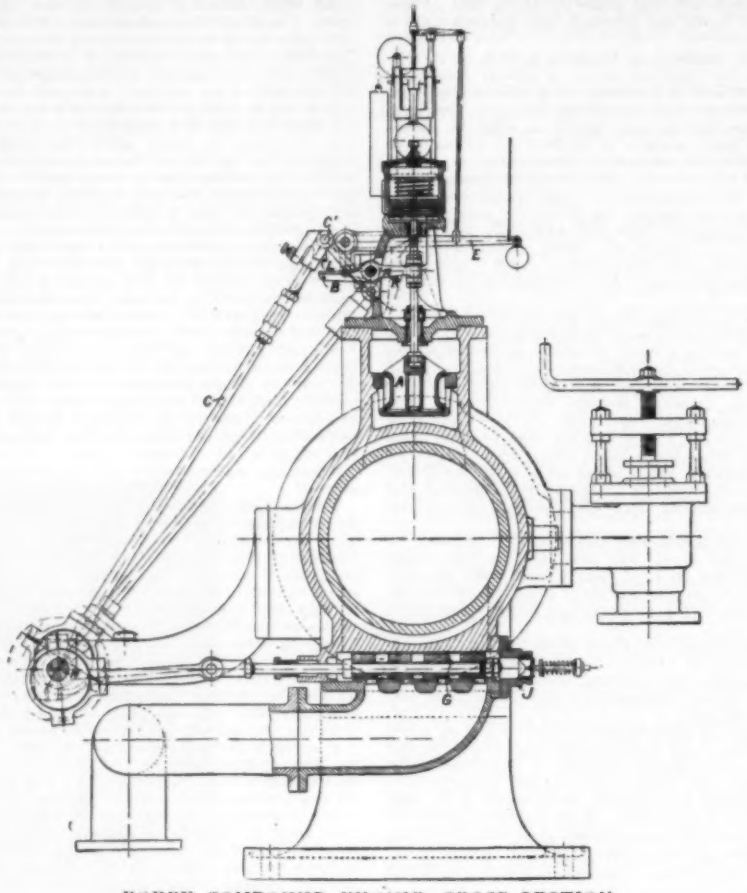
No high-water protection system can be complete without good transportation and good communication facilities. To make tools and materials readily available, supply depots should be established every five miles along the levee line, and these depots should be connected by telephone service.

Each of these depots should be provided with a house in which to store tools and materials and incidentally to furnish sleeping and eating quarters for watchmen and workmen; each depot should be equipped with two small flatboats to move tools and materials to points where they may be needed.

By the time the river has reached 42 feet at Vicksburg, and later on 42 feet at Red River Landing, there should be an inspector in the field having general supervision of the high-water work for about 135 miles of levee line. He should keep constantly moving over the line to instruct his assistants and to see that they properly discharge their duties; he should also keep himself informed as to the materials on hand as well as those which may be required.

Under his direction there should be inspectors having local supervision of the work on 20 miles of the levee line each. These men should inspect every foot of the levee line on their beat at least once in every twenty-four hours. As soon as they arrive on the ground, the embankment should be thoroughly cleared of all weeds and coarse vegetation, and the grass should be mowed close to the surface in order to fully expose the entire surface to the closest scrutiny. At the same time, existing drain ditches near the land base of the levee should be cleared and put in good order. If such ditches do not exist, they should be promptly cut. As the river rises, or the amount of protection work increases, the 20-mile beat should be reduced to such a length that the inspector can inspect every foot of it daily, and otherwise give it proper attention and competently direct all necessary work.

Whenever the water in the river gets within 3 feet of the crown of the embankment, a reliable day and night watchman, in addition to the inspector, should be placed on every 2½ miles of the levee line, and the watchmen should be required to constantly patrol their beats during during the night as well as during the day. If dangerous places develop, no matter what the height of the river may be, a day and night watchman should be retained at each of such places in addition to the patrol watchman.

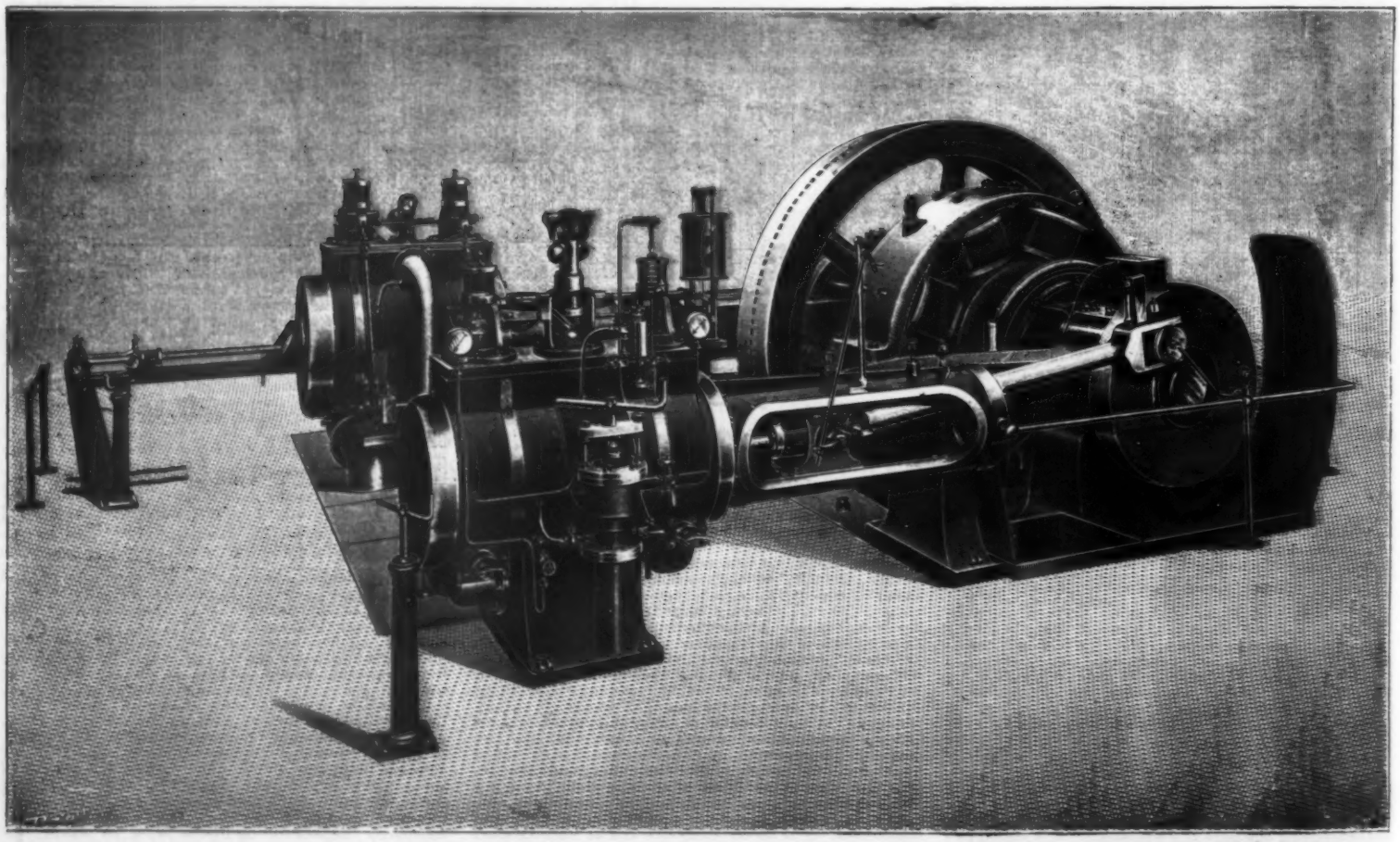


ROBEY COMPOUND ENGINE—CROSS SECTION.

THE PARIS EXPOSITION—COMPOUND ENGINE.

WE illustrate the new compound electric light engine exhibited by Robey & Company, Limited, Lincoln, England. In large engines, especially when working with steam of a high pressure, the power absorbed in working the slide valves is very considerable, amounting in extreme cases to as much as 10 per cent. of the total power exerted by the engine. All this, of course, is power wasted, and it has too long been the practice to regard it as a necessary evil. There are many valve gears in use which get rid of this objection more or less successfully. Usually their complication has proved a bar to their usefulness, many steam users preferring the old-fashioned slide valve to the multiplicity of small moving parts which appear to be the distinguishing feature of many modern valve gears.

In the Richardson-Rowland patent trip gear, with which the engine we illustrate is fitted, directness of action and simplicity are strikingly evident. The ordinary slide valve is discarded in favor of a couple of double-beat lifting-valves, one for each end of the cylinder. These are situated close to the extremities



THE PARIS EXPOSITION—COMPOUND ELECTRIC LIGHT ENGINE.

of the piston's travel, so that the clearance or waste room to be filled with steam at each stroke is reduced to an absolute minimum.

Referring to the cross-section of the cylinder, which shows very clearly the whole of the gear for one end of the cylinder, it will be seen that the small eccentric rod, *C*, is enabled to act upon the valve, *A*—which is in equilibrium—by depressing the outer end of the lever, *B*, by which the valve is raised. This occurs just before the commencement of the stroke. Owing to the different arcs described by the ends of the eccentric rod, *C*, and the lever, *B*, respectively, at a certain point, the tripper, *L*, slips out of contact, and the valve drops instantaneously, cutting off the steam supply. To prevent the valve being injured by coming too heavily on its seat, its stem or spindle is prolonged upward, and terminates in a small piston within the air cylinder or dashpot. A small air clack at the bottom of the air cylinder regulates the descent, so that the valve falls rapidly but without concussion. This is the whole of the mechanism concerned in the admission and cut-off of the steam at fixed points of the stroke. However, it is necessary that the point of cut-off should be variable by the action of the governor, so as to enable the engine to maintain a constant speed under fluctuations of load or steam pressure.

The centrifugal governor and the arrangement for securing an automatic cut-off are simplicity itself. The governor in rising moves the lever arm, *E*, and with it the pivot or fulcrum, *R*, of lever, *B*, which, of course, has the effect of causing the tripper, *L*, to lose its contact and the valve to fall at an earlier period in the stroke, and thus as the governor rises and falls the point of cut-off is accelerated or retarded accordingly. It will be noticed that the long horizontal arm of the lever is prolonged past the governor, and that a small cord, or string, is attached to it. This cord may be led away to any part of the building, and forms a ready means of instantly stopping the engine in case of emergency, as in the case of accident to life or machinery. By pulling the cord, which is done with no more exertion than is required to ring an ordinary house-bell, the lever, *E*, when raised draws the valve levers, *F B*, completely clear of the trippers, when, of course, no steam can enter the cylinders. With so sensitive an apparatus as this, accurate governing is easy of attainment, and a small and simple centrifugal governor fulfills every requirement. When the engine is used, as in this case, for electric lighting the Richardson patent electric governor is fitted, and coupled up to the governor lever, *E*, and the speed is regulated by the tension on the current itself in a way obvious at a glance.

We now come to the exhaust valves, *G*, by which the expanded steam is released from the cylinder. These are placed underneath the cylinder, and, like the inlet valves, close to the piston, so as to reduce the clearance to a minimum. Referring to the end view, which shows a cross-section of one of them, it will be seen to consist of a gridiron valve, sliding upon a treble-ported face or seat formed upon the upper surface of the exhaust branch, and worked by a small eccentric upon the longitudinal shaft, *H*—the same which actuates the inlet valves and the governor.

Although these are sliding valves, they are in practical equilibrium during the time they are moving, as the pressure of steam within the cylinder is reduced almost to nothing at the time of their opening and closing. In fact, the power required to move the whole valve motion is so small that even in a large engine the shaft, *H*, can be turned round by hand without difficulty. From the position of the exhaust valves beneath the cylinder, the latter is kept effectually drained of any water which may enter with the steam or arise from condensation—no cylinder cocks being necessary—and they are also peculiarly accessible for repairs or examination, as, by removing the cover, *J*, and loosening the locknuts from the spindle, the valve will draw out into the hand without interfering with any pipe joints. The exhaust branch can also be removed without disturbing the remainder of the exhaust pipes.

We may add that the finish of these engines is admirable, and that they are very strongly built, with large wearing surfaces. They are, in fact, very favorable examples of the best type of English horizontal engine work, and there is probably nothing better than that to be had.—The Engineer.

THE NEW ELEVATORS OF THE EIFFEL TOWER.

THE immense success of the Eiffel Tower at the Exposition of 1889 is still remembered. An interminable line of visitors pressed forward toward the wickets, and it was not always possible to carry up everybody. Nevertheless, on certain days as many as 23,000 ascents were made. Between the ground and the various platforms, there were four elevators arranged. Two of these, of the Otis system, were capable of carrying about 9,000 persons per day of ten hours, at the mean rate of 10 or 12 trips an hour and of 42 passengers to the car. On another hand, two elevators of the Raux and Combaluzier system, which did service only between the ground and the first story, were capable of carrying 18,000 persons in the same time. Finally, an Edoux elevator carried 4,500 persons up to the third story at the rate of seven trips per hour and of 65 persons per trip.

The management of the tower thought that inasmuch as the number of visitors expected to attend the Exposition of 1900 would be far greater than that of the previous exhibition, it would be well, in order to accommodate a much larger number of persons, completely to modify the system of elevators that did duty for the first and second stories.

But a single one of the two Otis elevators, that of the north pillar, was preserved. This is reserved for the service of the first story; but it has been so transformed as to make it capable of performing 14 trips an hour with 80 passengers to the trip, say 11,200 persons per day of ten hours. In the south pillar, there is no longer any elevator, but in lieu thereof there has been installed a wide stairway running up to the second story.

In the east and west pillars have been constructed by the Compagnie de Fives-Lille two entirely new elevators, which do service for the first and second stories, and are capable of making 10 trips an hour with 100 passengers to the trip, say 10,000 persons carried to the second story by each per day of ten hours. It was estimated, in fact, that the platform of the second story would be the one most frequented, and so this was cleared of the various constructions that encumbered it, in order notably to increase the surface put at the disposal of promenaders.

The installation of the new elevators necessitated the construction of new engines, which had to be housed in the hall in the south pillar, and since it was impossible to enlarge that, it became necessary to make the most of the slight space disposable. What rendered this installation still more difficult was that it was necessary in putting the new material in place to leave a portion of the old in service, at least for a certain length of time.

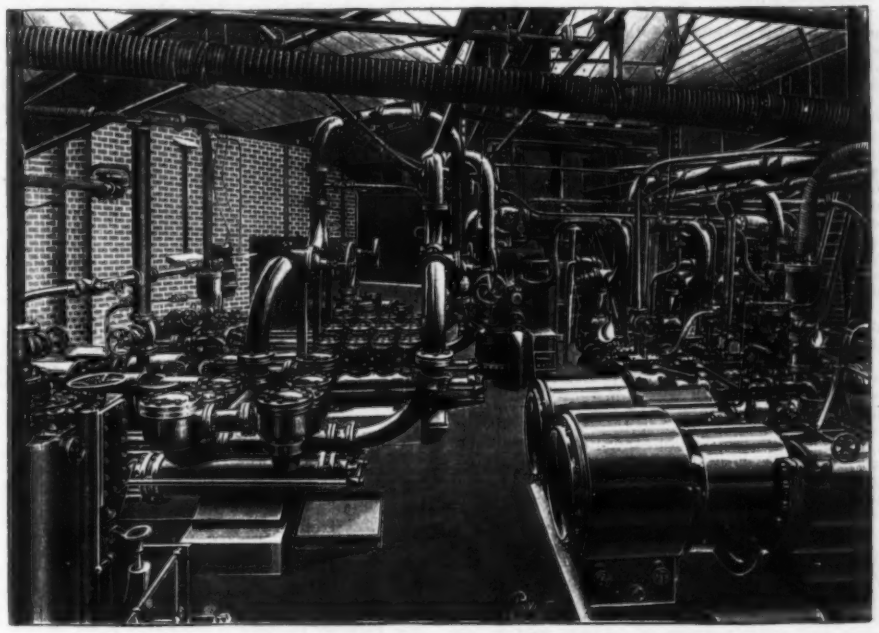


FIG. 2.—ENGINE ROOM OF THE EIFFEL TOWER.

Despite this, the skill of the engineers overcame all difficulties, and there is now to be seen one of the best of engine rooms (Fig. 2) filled with the steam engines, pumps and dynamos necessitated by the service of the tower.

Each of the new elevators consists of two superposed cars constructed partly of aluminium and capable of accommodating 50 passengers. They are connected by cables with a long horizontal piston having a stroke of about 59 feet, and for which a gallery extending beneath the Champ de Mars had to be dug (Fig. 3).

The cables are of steel wires, 216 in number to each. There are six of them, distributed in two groups of three each, which pass over guide pulleys, the principal ones of which, situated on the second story, are four meters in diameter. Each presents a great resistance to breakage and might alone support the entire weight of the cars.

Motion is communicated to the horizontal piston by

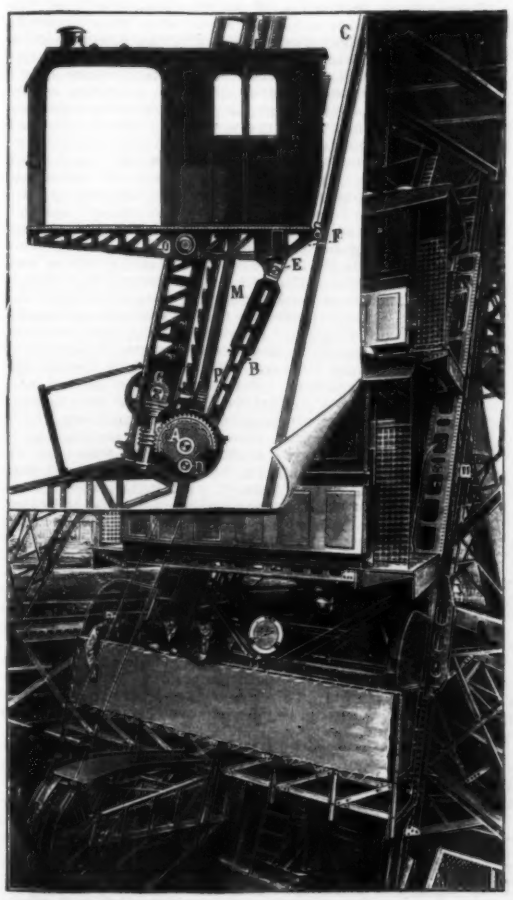


FIG. 1.—ARRANGEMENT FOR ASSURING THE HORIZONTALITY OF THE CAR FLOOR.

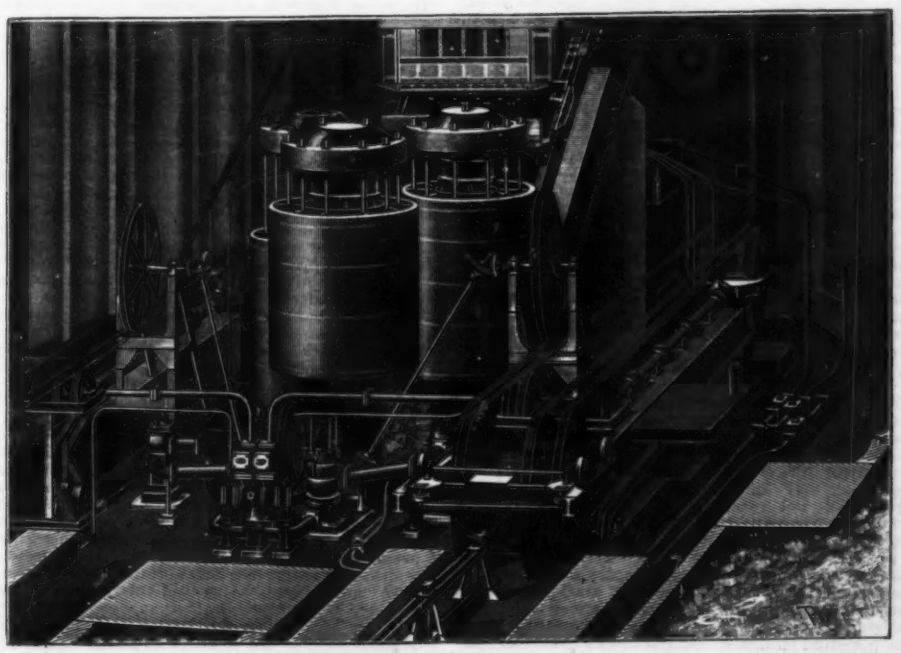


FIG. 3.—HYDRAULIC ACCUMULATORS AND PISTONS FOR ACTUATING THE ELEVATORS.

three hydraulic accumulators (Fig. 3) which develop 500 horse power. Although the stroke of the piston is but 59 feet, the car, owing to a system of compound pulleys, is made to accomplish the trip of 425 feet from the ground to the second story.

One of the accumulators is a low pressure one, and serves, in the descent, partially to recuperate the work expended in the ascent; so that an engine of 150 horse power is sufficient to actuate the pumps, the effect of which is to elevate the high pressure accumulator.

In order to have absolute security in case of a breakage of the suspension cables (a thing, however, that seems to be impossible), there are arranged under the car hydraulic brakes analogous to those of artillery guns. These brakes consist of four coupled pistons of 4·25 feet stroke. In case of breakage, they instantaneously actuate dogs that engage with racks provided with elongated teeth situated on each side of the guides (Fig. 1). The shock is deadened by the play of the pistons in their cylinders. Moreover, all along the car's course there is arranged a system of piping called a safety conduit, and which, through flexible tubes, may be connected with these pistons and actuate them; so that, through a series of couplings and a set of cocks it is possible by this means alone to cause the car to accomplish its entire trip. It is therefore always possible, slowly, but surely, to reach the nearest station.

In order to prevent too great a speed being given to the car by the operator, a ball governor is so arranged as to free the brake automatically. With such precautions, we may be assured that an accident on these new elevators is impossible.

The guides are formed of rails fixed to the framework of the tower between the ground and the second platform, and consequently are not vertical. With the old elevators, the result was that various inclinations were encountered during the trip, and the passengers were submitted to a disagreable sensation. Through a new and ingenious arrangement, a constant horizontality is maintained in the floor of the car. To this effect a rack, *M*, is placed along the entire line of travel and upon this rolls a pinion, *P*, mounted upon the lower car. This pinion actuates a train of bevel wheels, *C* (Fig. 1), which carries an endless screw that acts continuously upon a small toothed wheel, *A*, which thus revolves very slowly. This wheel is provided with a wrist pin, *D*, to which is attached a connecting rod, *B*, of which the other end, *E*, is fixed to the extremity of the car floor. As the car is mounted upon two pivots, it swings imperceptibly under the pressure of the connecting rod. The upper car is connected with the lower one by a jointed rod, *FC*, which communicates the same motion to it.

The Edoux vertical elevator, which runs from the second to the third platform, has received a slight modification, which, through an open imperial, permits of accommodating 80 travelers, whom it is capable of carrying without crowding.

With this new material, which cost more than a million francs, and which permits of quicker service, the receipts may be 60 per cent. greater than they were previously.—La Nature.

ELECTRICAL ENGINEERING AS A TRADE AND AS A SCIENCE.*

I DO not intend to make this in any sense a report of the progress of our Institution during the last or any number of years. I shall not, therefore, give any account of the exceedingly good work done by Colonel Crompton and the active service corps of our Electrical Engineer Volunteers in South Africa. I shall not describe how we feted our American cousins in England and France, or how they feted us; nor what a wonderful success accompanied all that was attempted by us or by them or by M. Mascart and our French colleagues, although I cannot refrain from bearing my testimony to the great kindness of the Prince of Wales and the British Commission in so generously lending us the British Pavilion for our great reception, and giving us the use of one of its rooms for our office all the time of our visit to Paris.

My brother has tried to get me to introduce to your notice some novel ideas which have come to us during the last ten years in our business of lighting the city of Galway from a fairly constant water power, using accumulators with a gas plant stand-by. It has almost come to be a practical idea to produce carbide of calcium in wet seasons and utilize it through the gas engine in dry seasons. I was also tempted to discuss the use of large gas engine plant at central stations; and another of several subjects in which I have been recently engaged has been the magnetic effect produced by systems of electric traction. But I have resisted temptation, and have chosen a subject which seems to me much more important.

Your president's address is followed by no discussion. He is, therefore, privileged, but his very privileges cause him to address you with a greater sense of responsibility; he may say what he pleases, but he must be very sure that he has the best interests of the Institution at heart; the interests of the Institution as a whole, not the interests merely of a few members, and least of all ought he to think of his own interests. Nevertheless, your president speaks not as an omniscient judge, but rather as a very fallible, very prejudiced, one-sided man who, because he has devoted himself to one part of the work of this Institution, is certain to be unfair in his comments upon other parts of the work.

Your past presidents represent in this way all classes of members of this Institution. You have had scientific men, given some of them to calculation and some to experiment, and some to both; men who have advanced the study of pure science. You have had practical telegraph men, civil and military; men cunning in land and deep-sea telegraphy and telephony; men cunning in railway signaling. You have had electrical chemists. You have had manufacturers and users of all kinds of electrical appliances. You have had men who devote themselves to the teaching of electrical engineers, and who fully appreciate the fact that no good teacher ought to be out of practical touch with the profession. And nearly all of your past presidents have invented things which are now in practical use.

As each of these men has given you at least one address written from his own peculiar point of view, his prejudices are not likely to have done any harm to members who read the other addresses. I know, therefore, that you are good-naturedly prepared to give me plenty of rope. I can predict the twinkle of amusement in the faces of some of my friends when they learn that I am about to take up a subject on which we have had many debates.

In this address I mean to put before you this simple question: Is electrical engineering to remain a profession or is it to become a trade? Is this Institution to continue to be a society for the advancement of knowledge in the applications of scientific principles to electrical industries, or is it to become a mere trades union?

Of course, at the present time the outside public are willing to regard membership of this Institution as a symbol of something more than the membership of a mere trades union. During the early growth of any trade, even such a trade as that of the plumber, it was really a profession. And a common trade may suddenly become a profession, if it suddenly begins to develop, as, for example, stone-masonry of a hundred years ago suddenly developed into civil engineering. Electrical engineering has been developed rapidly, so that in the past it has certainly been a profession and not a trade.

Again, we are an institution of engineers, and the general public are willing to class us with other engineering institutions—for example, the Institution of Civil Engineers. Now the title M.Inst.C.E. is a professional distinction which represents in civil engineering what F.R.C.S. does in surgery, or M.R.C.P. in medicine. We owe a great deal to our association with, and recognition by, the Institution of Civil Engineers; our meetings are held in its rooms; many of our members are also its members; our proceedings are modeled on its proceedings.

Now this older institution, governed by the best thoughts of the best British engineers, has laid it down that its associate members, that important class from which the higher class is mainly fed, shall have passed certain specified examinations in pure and applied science. I am not now suggesting that we ought to adopt this science examination method of admitting any kind of members to our Institution. I do not believe in the wholesale adoption of methods of working from another society. I am asking you early in my address to remember that this greatest of all professional engineering institutions, governed by practical men full of common sense, knowing the wants of their profession well, insists upon a knowledge of science in its new members. If this recognition of science did not exist anywhere else in the whole world, I say that its recognition by such a thoroughly good professional society as that of the Civil Engineers ought to recommend it to all professional societies.

In Germany an enormous stride has recently been made in the raising of engineering degrees to rank with the highest University honors. There is hardly one engineer of eminence in Switzerland, France or Germany who has not passed with honor through the classes of one of their great science Universities.* In Great Britain, within the last fifteen years, not only have great engineering schools been established in all the manufacturing towns, but even in Cambridge University there is one of the best schools of civil, mechanical and electrical engineering of which I know anything.

Before we think of imitating the Institution of Civil Engineers, we ought to reflect on certain fundamental distinctions between that Institution and our own, which at first sight seem to make us less professional.

There is a well known unwritten rule of the civil engineers, to which there are only a few exceptions, that no contracting railway or harbor engineer can acquire the title of M. Inst. C.E. I think myself that it is a pity to draw a hard and fast line between consulting engineers and contractors. No doubt it simplifies the labor of the council in its selection of candidates, but it gives rise to anomalies.

A man who was once a civil engineer because he served a pupilage under his clever father, and who now is nominally at the head of his father's large practice, the real engineering work being done by many clever employes, this man may be a member. A contracting engineer who shows marvelous ability, not only in rectifying the mistakes of the designer of a large bridge or tunnel or reservoir embankment, but shows the power of Lord Kitchener in directing the work of thousands of men, so that no man need be idle, and the whole contract goes on like clockwork, and is finished well in the minimum of time, this man is ineligible. Now, in our institution, it has been recognized from the very first that manufacturers and contractors and their employes may belong to the very highest ranks of their profession. Of course, I do not mean men who simply receive the profits of business, or even men who merely work to obtain orders for themselves. I mean men who are not merely formally, but in reality manufacturing or contracting engineers. I mean men who, in dealing with standardized things, design new methods for quick, good, cheap production of such things. I mean men who improve old forms of things, possibly through their paid subordinates. I mean by a manufacturer fit to be a M.I.E.E., a man who might act as his own manager, and who perhaps has a wider outlook than on mere managerial duties. So long as a contractor or manufacturer is really an engineer, we know that we add to our strength with the addition of every such member.

But consider a contractor who only uses ordinary types of machines or electrical plant in well known ways, surely he can hardly be said to be in the profession at all. Surely the one thing that differentiates us from mere tradesmen is that we do not follow mere rule of thumb methods; we think for ourselves, we weigh advantages and disadvantages. If every new installation required the same treatment as existing ones, the engineer would degenerate into a tradesman, and it seems to me that the electrical engineer ought to have a special fear of such degeneration.

In railway and harbor and river and sanitary engineering, in every new job, there are difficulties to be dealt with. An engineer who designs many undertakings and sees them carried out must be a thoughtful man; he cannot help keeping himself acquainted with engineering principles, and so he is a professional man. So an architect finds that each new job requires all his experience. Every case that comes before a real physician or surgeon requires a somewhat different treatment from any old case. Every case brought before a barrister requires the exercise of all his past experience. In every case a profession implies the necessity for the exercise of all one's past experience; because the work one has to do is never the same as any work one has ever done before. And when I say past experience, I really mean certain general principles which one has always in one's mind, principles derived from all that one has done or seen or read about.

Electrical engineering is in a curious position. It owes its being altogether to scientific men, to the laboratory and desk work of a long line of experimenters and philosophers. Even now the work going on in a laboratory to-day becomes the much larger work of the engineer to-morrow. When at length the laboratory experiment is utilized in engineering, we see that there is no other kind of engineering which so lends itself to mathematical treatment and exact measurement. Most of the phenomena dealt with by the electrical engineer lend themselves to exact mathematical calculation, and after calculations are made, exact measurements may be made to test the accuracy of our theory. For a completed machine or any of its parts can be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by the mechanical engineer, do not destroy the body tested.

Contrast this with the calculations it is possible to make in other kinds of engineering. The pressure of earth against a revetment wall is possibly 200 or 300 per cent. greater, or 50 to 70 per cent. less than what we imagine it to be in what some limited men call theory. We use factors of safety 5 or 10 or more on all kinds of iron structure calculations, because we are aware of our ignorance of a correct method of dealing with the problems. The civil engineer never has exactly the same problem as has already been solved. In tunneling, earthwork, building, etc., in making railways and canals, he is supremely dependent on the natural conditions provided for him; the configuration of the surface of the ground, the geological formation, the structural materials available in the neighborhood. The story of how the engineer has to study the endlessly different ways of interaction of water and sand and gravel is told by the troublesome bars at the mouths of rivers all over the world, by the difficulties of coast and river-bank protection, by the failure of sea walls and piers. But why should I make a catalogue of the different kinds of work done by civil engineers? Every one of them needs the exercise of general scientific principles due to much experience.

Now of all such natural difficulties the consulting or contracting electrical engineer is greatly independent. Give him a source of power, and tell him what is to be done: whether he is to light a town or a building, whether with arc or incandescent lights; whether he drives a stamp mill near a mine or a pump, or a machine tool, or a spinning frame, the electrical part of the work is carried out in much the same way. Natural conditions affect him mainly in the cost of transport of his materials and the cost of labor. He can make in an easy way the most careful calculations as to the best arrangement of his conductors and machines to give maximum economy, and except for this easy calculation his work is that of a mere tradesman. He is practically independent even of the weather. There are, indeed, some of us who grumble that this easy calculation is not made easier still, who prefer to make arithmetical guesses rather than exact calculation, because perhaps we like to see a little uncertainty introduced into the problem, to make it more like a problem in civil engineering. I want members to see clearly that as times go on, as our electrical engineering work gets more and more cut and dried, the man who loses the power to calculate, who loses his grip of the simple theory underlying our work, must sink more and more into the position of a mere tradesman who has no longer the right to call himself an engineer.

An electrical engineer must have such a good mental grasp of the general scientific principles underlying his work that he is able to improve existing things and ways of using these things. It has become the custom to call this theory, and I suppose I must follow the custom. I should prefer to call it science* or knowledge. Do you remember Huxley's definition of science? "Science," he said, "is organized common sense;" and this is really what I mean. Well, calling it theory, the man who is permeated by theory, whose theory is so much a part of his mental machinery that it is always ready for practical application to any problem, he is the real engineer. But you must not mistake me in this matter. Eighty per cent. of the men who pass examinations in mathematics, mechanics and electricity have very little of this theory. Fifty per cent. of the writers of letters in the engineering journals in which mathematical expressions occur have almost nothing of this theory in their possession. It is unknown to foolish men. Books alone, lectures alone, experiments alone, workshop experience alone, cannot teach this theory. The acumen of a Q.C. may actually prevent a man from acquiring it. A man may have much of this theory, although he may never have listened to lectures, although he may dislike the sight of a mathematical expression. I have known men who might be called illiterate to possess much theory. I have known many men who might be called good electricians who are almost wanting in the theory necessary for the electrical engineer.

I am speaking only of theory. Of the other qualifications for an engineer I need not here speak: they are present to the minds of all of us. A man may have

* Inaugural Address, delivered at the Institution of Electrical Engineers on November 8, by Prof. John Perry, F.R.S., President.

* I understand also that the great unions of manufacturers in Germany are about to make facilities for giving a year of real factory work to the Polytechnic students, thus perfecting the German system. In Japan we found great success in requiring students to spend their summer in real shops, their winters at college. In England it may be that we shall prefer to let apprentices have shorter factory hours than workmen, their masters being responsible for instruction being given in theory.

* What Falstaff said of the word "occupy" we have to say of the word "science." It is used by many people out of its proper meaning and then condemned, so that one is getting afraid to use it. In Prof. Fitzgerald's splendid inaugural address to the Dublin Section of this Institution he says: "As has recently been pointed out to me by Dr. Trouton, it would be impossible to say the same contemptuous things of knowledge as are said of science. In Germany the word used, 'wissenschaft,' is the one corresponding to our word 'knowledge,' and there nobody of any sense could say that 'knowledge is all humbug,' as is here often said, and still oftener thought, of 'science.'"

any amount of knowledge; he may know how to apply his knowledge, and yet he may not be able to apply the knowledge from a want of engineering character.

The engineer must be a real man; he must possess individuality, the power to think for himself. He must not be like a sheep, knowing only enough to follow the bell-wether. Over and over again in the last thirty years have some of us given our students much the same sort of advice that Baden-Powell gives to scouts in that excellent little book of his. If any of you have not read that book you ought to buy it at once, and you will there find that if a man is to think for himself he must possess all kinds of knowledge, he must be constantly picking up new kinds of knowledge.

Nobody can limit the value of any kind of knowledge, but still one may say that certain things are probably more important than others. To gain what we call "theory," a good general education is most helpful—mathematical knowledge is very helpful; laboratory and workshop experience are extremely helpful. There is one qualification which the electrical engineer must have and without which all other qualifications are useless, and if a man has it no other qualification is supremely important, and this absolutely indispensable qualification is that a man shall love to think about and work with electrical things. He must like these, not because of the money he can make through electrical contrivances, nor even, I think, because of the name he may make before the world—this would be mere liking or cupboard love which has no lasting quality. So long as we have men in this country who have the true love for scientific work of which I speak, so long shall we have a real profession of electrical engineering, for such men are always scheming new contrivances and improving old ones and utilizing the services of all helpful people, and especially of capitalists. When we have reached a state in which nobody schemes new things because the existing things are perfect, there will no longer be a profession of electrical engineering. Of all ideas, surely that of having reached perfection is most hateful; the idea of exact knowledge, that nothing is unknown, that there is no need for thought, and therefore that to think for one's self is a sin.

And so, although we are all agreed that much standardization in our contrivances and methods is absolutely necessary for our competition with other nations, we must follow the Americans in this matter and take care that it does not destroy invention. Of course when things are really standardized, when we have our perfect Mauser rifle or dynamo or locomotive or traction engine or electrically driven stamp mill, a Boer can buy or even manufacture them if he has money, and he can use them as well as, or possibly better than, we can. But he is not an engineer. He uses things after the engineer has done his work upon them. A stoker, a common engine driver, the guard of a train, these are not engineers. You must have noticed that the American engineers, who surely deserve the character of being practical idealists above all other engineers, are the men who are most imbued with notions of standardization which lead to cheapness of manufacture, and they are also the men most alive to the necessity for occasional scrapping of types of machinery when they become even a little antiquated.

Our chiefs, the men who run us all, our real men at this Institution, may be called Practical Idealists. They have imagination and judgment and individuality. They have the imagination and enthusiasm of inventors, and yet they are more than inventors, for they can estimate the worth of their own inventions and control their imaginations. They are ready to receive all new things, and yet they are not carried away. They are radicals and yet they are conservatives. They have what Mrs. Beecher Stowe called faculty.

A strong imagination well under control, surely it is the greatest of mental gifts. I look round me and wonder how many of us really have it; and how many of us are only dull, music-hall loving men, who scorn novels and poetry, who live utilitarian, material lives, whose aim is merely to make money through electricity, who love it not for its own self, who cherish their "tuppeny-ha'penny-worth" of theory because it is sufficient for their immediate wants. Why, even the writers of leading articles in the daily papers can talk of the wonders of electricity and what may yet come to pass; and yet we who make machines and use them and switch the marvelous thing on and off and take all sorts of liberties with it—we are like Calibans oblivious of the wonders of the fairy isle; like soulless priests making a living in the temple of Isis; like Aladdins who rub our lamp only to get the necessaries of life.

Twenty years ago some of us were laughed at for our optimism, and yet everything that we declared then to be doable has now actually been done by engineers, except the thing which was then and is now declared to be the supremely important thing, namely, the electric consumption of coal. We say now, as we said then, "The applied science of the future lies invisible and small in the operations of the men who work at pure chemistry and physics." And think of the wonderfully rapid rate at which laboratory discoveries have been made in the last eleven years, and how, as the years go on, they become more and more numerous; and yet many of us plod along with our work, seeing no farther than our noses. A year is now more pregnant with discovery than a hundred years used to be, and yet the protective stolidity of our ancestors is upon us, and we think of the latest discovery as if it were really the very last that can be made. A thousand men are measuring and trying new things in laboratories all over the world. Some of them plodding and soulless; others of them with imagination and clearness of vision. Do you think that nothing is to come from all that work?

And is it not one of the most important functions of the engineer to do as Mr. Marconi has done, to convince capitalists ignorant of science that if the successful laboratory experiment is tried on a large scale, it must also be successful? And are we going to leave all this pioneering work, with all its possibilities of great gain, albeit with possible loss, to foreign engineers, when in most cases the scientific discovery has been made in England? Are we so lacking in the hope and faith which are born of imagination and science? And must we in the future, as in the past, have to rely upon the influx of the clever foreigner like Sir William Siemens? Must we, Boer-like, always depend upon our Uitlander population, Fleming and German, Hollander, Huguenot, and Hebrew, for the development of our natural resources?

Some of the best engineers I know are so exceptional that one must class them with geniuses; they have faculty and character, and so they have become engineers, even under the most unfavorable circumstances. They have passed through ordinary schools and yet developed common sense. They were pitchforked into practical work, and their liking for the work, as well as some curious kind of instinct, led them to pick up all sorts of knowledge, which have become part of their mental machinery. They continue to pick up new kinds of knowledge when these become necessary for their professional work. Unfortunately, these men do not realize how exceptional they are, and they advise boys to go direct from school into works. They forget that the other 99 per cent. of men treated in the same way as themselves can only become the hewers of wood and drawers of water to real engineers. Treated in this way, average boys are just like so many sheep; they learn just what seems absolutely necessary and no more; their acquaintance with the scientific principles underlying their trade is a hand-to-mouth knowledge, which becomes useless when their trade undergoes development.

In 1867 I was an apprentice, and when in the drawing office and pattern shop I remember well how I was chaffed for studying such a non-paying, non-practical subject as electricity. When I published my first electrical paper in 1874 before the Royal Society, and even for some years afterward, the real students of electricity in England could be counted on the fingers of one's hands. Many of us remember the first Gramme magneto machine that came to this country, a scientific toy, in 1874. How many engineers dreamt that a great new branch of engineering had been started? Even in 1878 engineers were, as a rule, quite ignorant of electricity, and since then every year, although newspaper writers have talked largely of the age of electricity, the men actually engaged in electrical industries have acted as if the greatest of changes were not perpetually going on in it. To be left behind, or to become camp followers, children of Gibeon, this is the usual fate of the men who scorn theory. In 1882–4, we used to have to pay men £200 and £300 a year because they had a slight knowledge of electrical matters. In 1884–6 these very men were not worth twenty shillings a week; they were weeded out of the profession, and their places were taken by men of better knowledge. Two or three years after, these better men were again found to have been weeded out, because men of still better knowledge were available. And so it has gone on ever since. Men learn just enough to get posts; they settle down in these posts and scorn theory. They actually forget what little theory they once did possess. They know a great deal about existing machines, but presently they discover that improvements have been going on, and that they no longer have a right to say that they belong to the engineering profession. In every year one has told men, "You will be left behind. See A and B and C. I told them three years ago, when their names were in everybody's mouths, that they would be left behind like their predecessors, and they laughed. Now I tell you and you laugh, and you also will be left behind. Yes, I know that you get a good salary or large fees, and your head touches the sky. Nevertheless, because you neglect theory and the simple mathematics, by means of which theory is made available in practical problems, you will have to take a back seat presently, for our profession is in its early youth and is growing rapidly."

Remember that I do not now refer to the few exceptional heaven-born engineers who, in spite of bad training, do manage somehow to pick up the necessary knowledge. I speak of the average men, many of whom are now living in the same old fool's paradise. They know enough for present needs; they scorn the simple principles which underlie all our work; they scorn the easy mathematics by which these principles are most readily employed in practical problems; they will have their reward.

Just think of what is occurring at the present time. In England we have cheap coal, and it can be carried easily. In Switzerland and other countries where there is no cheap coal the water power had to be utilized and power had to be transmitted great distances electrically. This needed high voltage, and as it is difficult to get high voltage with direct current machines, alternating currents were used, and on account of motor troubles multiphase working has been introduced. What a revelation it was to almost all of us, that visit of a year ago to Switzerland! We saw enormous schemes of lighting and traction and power. We saw electric trains driven by distant waterfalls sandwiched in among ordinary trains keeping proper time on working railways. We had known that there were great schemes carried out in Germany and America and other countries, and yet all the machines were quite unfamiliar to us. We were very much like what engineers of 1870 would have been if suddenly brought into a generating station. Is it not a fact that some of us, said to be eminent and thought to be practical, asked questions and made remarks which showed that we did not know the most elementary principles of three-phase working? Is it then any wonder that the traction schemes now being developed in England, on lines that are certainly not the best for this country of their adoption, are altogether dependent on the use of foreign electrical machinery and employ foreign electrical engineers? I am not putting this altogether fairly, for municipal procrastination has prevented our development, and yet I am not putting it altogether unfairly. We know too little theory.

I am afraid just now we are rather in a tight place. I would give something to know how we in this room are going to get acquainted with modern electrical engineering. Our usual way of learning is by actual handling of things. But if the millions of pounds' worth of machinery coming to England every year is all foreign, and is used mainly under foreign superintendence, our usual method of study is made very difficult. True, there are American and German and, indeed, English publications which would give a knowledge of the theory, but not, I think, to the average English electrical engineer. I know of many men, twenty-five to forty years of age, who seldom come to our meetings, and who say that they are silent in discussions because they cannot be understood; perhaps these men will find a way to save us all from being left behind. There is much more that I might say in this connection. An individual Englishman may be left behind other Englishmen, and all English electrical engineers may be left behind the rest of the world, but all electrical engineers of the world may even be left behind other appliers of science. It is not merely that the incandescent mantle of the gas engineer is improving and necessitates improvements in our filaments, but, in spite of the flourishing conditions of our factories just now, I could give many other illustrations of how we shall all suffer if we do not keep adding to our knowledge. Twenty years ago, when giving some lectures in Clerkenwell to workers in the then flourishing watch trade, I ventured to prophesy the decay of that trade. But I am afraid that the case of Jonah and Nineveh is the only one in which prediction of disaster led to reform. I venture on no prophecy, therefore, because it might harden your hearts.

(To be continued.)

WIND POWER.

THE utilization of wind power for the generation of electricity continues to receive attention in Germany, and we learn from the Elektrotechnische Zeitschrift that Mr. Gustave Couz, of the Gustave Couz Elektricitäts Gesellschaft, in Hamburg, has been experimenting in this direction with promising results. A wind motor has been erected at the works of the company in question, which has a diameter of 40 feet and an effective sail surface of 1,070 square feet. The motor works at the rate of about 11 revolutions per minute, which speed is regulated by automatic modification of the direction of the sails to the wind. With this motor an output of 1 horse power to 30 horse power and more may be obtained, according to the force of the wind, which power is transmitted to a 30 horse power shunt-wound iron-clad dynamo, designed to give 130 amperes at 160 volts terminal pressure when running at 700 revolutions per minute. The current generated by this machine is conducted to a switchboard and thence to a battery of accumulators having a capacity of 66,000 watt-hours, or may be delivered to electromotors. So soon as the wind has attained a velocity of 8 feet per second, the dynamo may be brought up to its full terminal pressure. With an increasing wind force the charging of the battery may be commenced. Automatic cut-outs for the dynamo were proved unnecessary with the arrangement adopted. The electromagnets of the dynamo are permanently excited by the battery, the + pole being connected with the battery, while the — pole is connected to the charging switch. By this arrangement automatic regulation of the dynamo voltage is secured. An automatic battery-discharging switch serves to maintain the line tension of 110 volts constant, both during the charging process and when discharging. Small motors are connected up to the lighting circuits, but larger ones are supplied by separate circuits branched off from the terminals of the generator.

AMERICAN TRADE WITH SOUTH AFRICA.

THE British and South African Gazette calls the attention of the British and South African public to the fact that American manufacturers are making great headway in the markets of Africa, and, as showing what has been done in the last few years, gives the following facts, which are of considerable interest:

"In December, 1897, American makers had in hand orders for 60 saloon carriages for the equipment of the eastern section of the Cape Government railway, and in that month six 50-ton locomotives were delivered at the Cape Government railway works from the Baldwin Works of Messrs. Burnham, Williams & Company, Philadelphia.

"In March, 1896, six improved Pullman cars were landed at Cape Town for the Cape Government railway.

"In July, 1900, several Baldwin locomotives were delivered at Cape Town in part completion of Cape Government contracts. In that month, according to the general manager of the Cape Government railways, there were still 39 engines and about 160,000 pounds sterling worth of trucks and other rolling stock on order in England and America. Four engines built by Messrs. Dickson & Company, Philadelphia, for the Selati railway, have been acquired by the Cape Government, and are now running on the Wynberg branch.

"In September, 1900, the Union Switch and Signal Company, of Pittsburg, U. S. A., had in hand a large order for special frogs and switches for the Cape Government railways, and several side tank engines from the Baldwin Works were daily expected to be delivered at Cape Town for the railways.

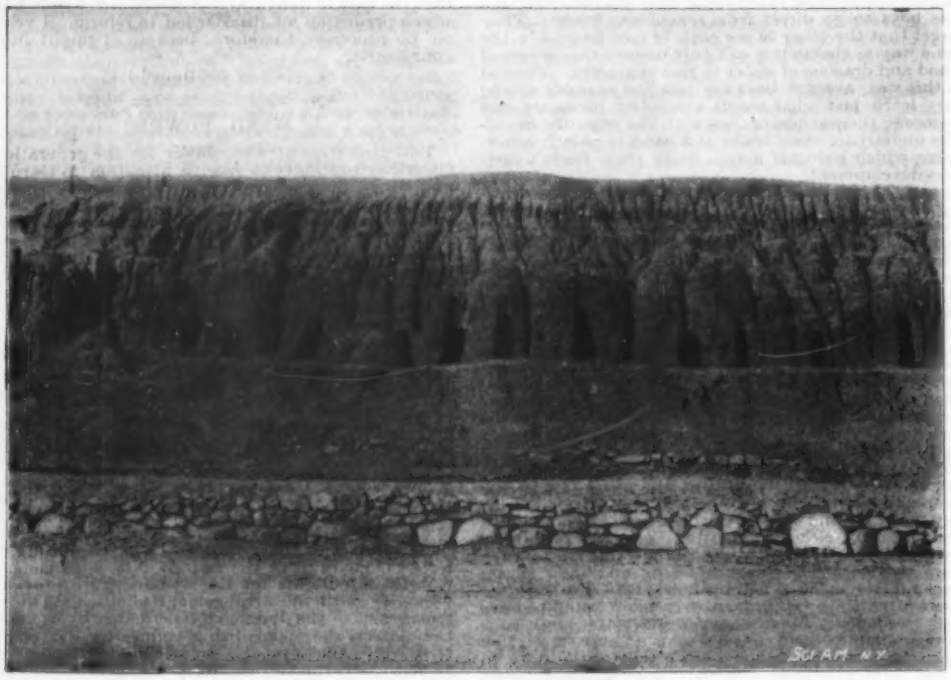
"In September, 1900, the Pressed Steel Car Company of Pittsburg, U. S. A., had in hand an order for the Cape Government railways for several steel platform cars of 40 tons capacity.

"Apart from these items it is significant that for the year ending June 30, 1899, the United States of America shipped 40,691 tons of steel rails to South Africa (value 160,000 pounds sterling), as against 3,105 tons (value 13,141 pounds sterling) in the previous year. In the estimates of the Cape Government for the current year the sum of £645,802 sterling is put down for rolling stock, locomotives, etc., but nothing is, of course, said as to where these large orders will be placed.

"I do not altogether blame the Cape Colony for thus diverting a large share of its orders to other countries, for it is notorious, as Sir Walter Peace has remarked, that, as time is now the essence of the contract, British engineering firms have been and are unable to accept them, the work already in hand being more than they can overtake. Price, too, is an important factor, and especially is this so with railway material, locomotives and trucks, which cost considerably less in the United States than in the United Kingdom. It is, however, impossible to overlook the fact that many important orders have gone to America from the Cape that could have been placed in this country had efforts been made to this end; and rightly or wrongly, a suspicion exists in the minds of manufacturers that is entirely due to the anti-British tendencies of some of the Cape's officials. Whatever the reason, the empire at large will agree that it is disgraceful other countries

should reap the advantage of the unparalleled sacrifices we have made in the Boer war; and while admitting that governments, like individuals, must be guided by business prudence, it will certainly be lamentable if every effort be not strained to check the tendency to favor the foreign manufacturer at the expense of his British competitors.

"There is one way where by the tender system leads to the diversion of orders to America, even despite the good intentions of the Colonial Governments. This is in cases where no stipulations are inserted in the contracts that the material employed shall be ordered of British manufacturers. Quite recently an order for rails for a Natal municipality found its way to the Lorain Steel Company, Johnstown, Pa., in this way—



A STREET OF BOMB-PROOF SHELTERS.

wholly, it is permissible to believe, against the intentions of the municipal authorities, and possibly against the intentions of the contractors, who had probably based their estimate on the lower American cost."

KIMBERLEY CAVE-DWELLINGS.

THE Transvaal war, particularly the Boer attack on Kimberley, has attracted no little attention to the great mines from which the world derives the larger portion of its diamonds. In order to protect themselves from the Boer shells, the sorely-pressed inhabitants burrowed in the diamond-mine tailings, in which they lived until relief came. Our engravings, taken from The Illustrated London News, describe better than words how hard put to it the people of Kimberley must have been during the long, anxious siege.

THE POPULATION OF THE UNITED STATES DURING THE NEXT TEN CENTURIES.

By H. S. PRITCHETT, President of the Massachusetts Institute of Technology.

Is it possible to predict with any degree of certainty the population of a country like the United States for a hundred years to come? Doubtless the average intelligent person would say A priori that the growth of population is not a matter which can be made the subject of exact computation; that this growth is the result of many factors; and that those factors are subject to such great fluctuations that an estimate of the population a hundred years hence can be, in the nature of the case, only a rough guess.

It is true that the growth of population depends on a number of factors. It is also true that these factors vary in accordance with laws which are at present not known. Nevertheless, it does not by any means follow that because the law of these variations is unknown we cannot represent the variations themselves by a mathematical equation. The problem of representing mathematically the law connecting a series of observations for which theory furnishes no physical explanation is one of the most common tasks to which the mathematician is called. And it does not in the least diminish the value of such a mathematical formula, for the purposes of prediction, that it is based upon no knowledge of the real causes of the phenomena which it connects together.

To illustrate: The black spots on the sun have been objects of the greatest interest to astronomers ever since Galileo pointed the first feeble telescope at his glowing disk. These spots, as observed from the earth, seem to pass across the disk from east to west as the sun rotates on its axis.

Among the problems with which the possessors of the first telescopes busied themselves were the observation of these spots for determining the period of the sun's rotation. The observation is a simple one, and consists merely in noting the time which elapses between successive returns of a spot to the central meridian of the disk. The earlier observers were astonished to find that the different spots gave different results for the rotation period, but it was only within the last thirty years that the researches of Carrington brought out the fact that these differences follow a regular law showing that at the solar equator the time of rotation is less than on either side of it.

The explanation which is generally accepted to account for this peculiar state of affairs is that the spots drift in the gaseous body of the sun and that this drift is most rapid near the equator and diminishes toward the poles. But this, after all, only pushes the explanation a little further back, and no satisfactory theory of this drifting of the spots has ever been reached. Doubtless the phenomenon is due to a large number of causes, acting together, whose resultant effect is shown in the motion of the spots as we see them.

However that may be, and although we are still unable to give any physical explanation of the phenomenon, a formula has been devised which fits the observations fairly well and which enables the astronomer to predict the motion of the spots with an accuracy comparable to the observations themselves. This formula is a complicated one, when written in its mathematical form, and involves a trigonometric function of the latitude of the spot raised to a fractional power.

Now, no one pretends that this intricate formula expresses any real law of nature. But it does express the mathematical relation which connects together the observations, and by means of it the motions of the spots at different latitudes on the sun may be predicted with all desirable accuracy.

The problem of deriving an equation which shall represent the growth of the population of the United States during the past one hundred and ten years, and which may be used to predict its growth through future decades, is exactly such a case as that of the sun's spots just mentioned. The observations in this case consist of eleven determinations of the population as given in the census returns from 1790 to 1890.

In studying these observations of population, taken at regular intervals of ten years, it occurred to me some years ago to examine them with some care, in order to discover whether they were related to each other in any orderly way, and if so whether they could be represented by an equation of reasonable simplicity. It is evident that if an equation can be found which will fit the growth of population during the hundred years which intervened between 1790 and 1890, it would form the most probable basis for predicting the population of the future

Somewhat to my surprise, I discovered a comparatively simple equation which represented the census-enumerations very closely, and which, notwithstanding the fluctuations in the various factors which affect the growth of population, followed the general course of this growth with remarkable fidelity, as will be seen by the following table, which shows the population as given by the Census Bureau and as determined by the empirical formula. The discrepancies between the observed population and that computed from the formula are also given for the sake of an easy comparison. In each case the population is given to the nearest thousand, a figure far within the limit of error of the census count.

Year.	Observed Population.	Computed Population.	Discrepancy.
1790.....	3,929,000	4,012,000	83,000
1800.....	5,308,000	5,267 000	41,000
1810.. ...	7,240.000	7,059,000	181,000
1820.....	9,634,000	9,569.000	65,000
1830.....	12,866,000	12,985,000	119,000
1840.....	17,069,000	17,484.000	415 000
1850... ..	23,192,000	23.250.000	58,000
1860.....	31,443,000	30,468.000	975,000
1870.....	38.558,000	39,312.000	754,000
1880.....	50,155.000	49.975,000	181,000
1890.. ..	62,622,000	62,634,000	12,000

The smallness of the discrepancies and the consequent close agreement of the formula with the observations show that the growth of the population has been a regular and orderly one. There are, however, two residuals which have abnormally large values. The census of 1860 shows a population of 975,000 larger than the computed value, while that of 1870 falls 754,000 below that of the computed value.

The explanation of these discrepancies is not far to seek. The devastating effect of the war would show itself in the census of 1870 and succeeding years. The effect would be to give 1870 a smaller observed value than would be expected. This is precisely what we find to be the case, the census of that year falling 754,000 short of the computed value. An abnormally small value in 1870 would, of course, have its effect on the population of succeeding decades and would also give an apparent difference of opposite sign to the observed population in 1860.

There is, however, good reason to believe that the population in 1870 as determined by the census was much smaller than the actual population at that time. Mr. Robert Porter, in Census Bulletin No. 12, October 30, 1890, makes the statement that the census of 1870 was grossly deficient in the Southern States, and that a correct and honest enumeration would have shown at that time a much larger population than that actually returned by the Census Bureau. There are, of course, no means of ascertaining exactly the extent of these omissions, but there is no question that the population as computed by the formula for 1870 is far nearer the truth than the value given by the census for that year.

However this may be, it is evident that the formula represents the general law of growth which held between 1790 and 1890 with an accuracy almost comparable with that of the census determinations themselves. The question of immediate interest, however, is not whether the growth of population during the last century can be represented by a mathematical formula, but it is that which stands at the beginning of this paper, viz., can the population of the United States a hundred years hence be predicted within reasonable limits of error?

During the past century the factors which govern the growth of population have fluctuated enormously: there have been wars and epidemics; there have been decades in which large numbers of emigrants landed upon our shores, and there have been other decades in which emigrants were few; there have been years of plenty and years of want; booms and panics, good times and hard times have had their share in the century which has passed. Yet notwithstanding all these varying conditions, the growth of the population has been a regular and orderly one, so much so that it can be represented by a comparatively simple mathematical equation. Can this equation be trusted to predict the population in the decades which are to come?

How closely the formula will represent the popula-

A NEAR VIEW OF THE SHELTERS.

tion of the future will depend, of course, upon the continuance of the same general conditions which have held in the past. This does not mean that exactly the same factors are to operate, but that on the whole the change of one factor will be balanced by a change in another, so that in the main the character of the growth manifested during the past century will be continued. A decided change in the birth-rate or a widespread famine would bring out large discrepancies. But on the whole it may be expected that the experience of the last hundred years involves so many varying conditions that the general law of growth which satisfies that period will continue to approximate the development of the population for a considerable time to come.

This does not mean that any particular census enumeration of the future will be represented closely, but simply that in the main the computed values will follow the general growth of the population. The law of probabilities will lead one to expect at times considerable variations. The preliminary announcements from the Census Office, as given in the daily papers, indicate a result for 1900 of about 75,700,000 people, a value considerably below the computed one. This would mean that at this epoch the formula was not representing the actual growth, but does not at all indicate that it will cease to represent the general growth of the succeeding centuries. In any event this method furnishes the most trustworthy estimate which can be made for the future, since it gives the result which is mathematically most probable, and which is based on all the data of the past. Carrying forward, therefore, the computation, we obtain the following values for the most probable population of the future:

Year.	Computed Population.
1900	77,472,000
1910	94,673,000
1920	114,416,000
1930	136,887,000
1940	162,268,000
1950	190,740,000
1960	222,067,000
1970	257,688,000
1980	296,814,000
1990	339,193,000
2000	385,860,000
2100	1,112,867,000
2500	11,856,302,000
2900	40,852,273,000

The law governing the increase of population, as generally stated, is, that when not disturbed by extraneous causes such as emigration, wars, and famines, the increase of population goes on at a constantly diminishing rate. By this is meant that the percentage of increase from decade to decade diminishes. It will be noticed that the figures just given involve such a decrease in the percentage of growth. A simple differentiation of the formula gives as the percentage of increase of the population per decade 32 per cent. in 1790, 24 per cent. in 1880, 13 per cent. in 1990, while in one thousand years it will have sunk to a little less than 3 per cent. But according to the formula this percentage of increase will become zero, or the population become stationary, only after the lapse of an indefinite period.

The figures just quoted are, to say the least, suggestive. Forming, as they do, the most probable estimate we can make for the population of the future, they suggest possibilities of the highest social and economic interest. Within fifty years the population of the United States (exclusive of Alaska, of Indians on reservations, and of the inhabitants of the recently acquired islands) will approximate 190,000,000, and by the year 2000 this number will have swelled to 385,000,000 of people; while should the same law of growth continue for a thousand years, the number will reach the enormous total of 41,000,000,000.

How great a change in the conditions of living this growth of population would imply is, perhaps, impossible for us to realize. Great Britain, at present one of the most densely populated countries of the globe, contains about 300 inhabitants to the square mile. Should the present law of growth continue until 2900, the United States would contain over 11,000 persons to each square mile of surface.

With the growth of population our civilization is becoming more and more complex and the drafts upon the stored energy of the earth more enormous. As a consequence of all this, it would seem that life in the future must be subject to a constantly increasing stress, which will bring to the attention of individuals and of nations economic questions which at our time seem very remote.

We are indebted to The Popular Science Monthly for the above interesting forecast.

PROF. FRIEDRICH MAX MÜLLER.

FRIEDRICH MAX MÜLLER, the eminent Orientalist and philologist, who died October 28 at Oxford, was the son of Wilhelm Müller, the German poet, and was born at Dessau on December 6, 1823. He was educated at the public schools of Dessau and Leipsic, and later attended lectures in the universities of Leipsic and Berlin, taking his degree in 1843. Arabic and Persian he studied under Prof. Fleischer; Sanskrit and comparative philology under Brockhaus, Bopp, and Rückert; and philosophy under Drobisch, Weisse, and Schelling. In 1848 he settled at Oxford, where the first volume of his work on the Rig-Veda appeared in 1849. He was made curator of the Bodleian Library in 1856, and became a Fellow of All Souls' College in 1858. From 1865 to 1867 he was Oriental Librarian, and in the following year he was made the first professor at Oxford of comparative philology. In 1868 he delivered the Rede lecture at Cambridge, and in 1870 he gave a course of lectures on the Science of Religion before the Royal Institution. He also lectured before the Royal Institution in 1873 on Darwin's "Philosophy of Language." He was the recipient of innumerable honors and degrees from various scientific societies and institutions of learning in England, Germany, France, Italy, and America. In 1889 he was elected first President of the Aryan section at the International Congress of Orientalists held in Stockholm, and in 1892 he was President of the congress held in London. The Sultan decorated him when he visited Constantinople in 1893. He was made a member of the British Privy Council in 1896.

In this decade have died three men who, born in the twenties within five years of each other, have occupied, each in his own field, the same relative position in respect of science on the one hand and of the general public on the other. Tyndall, Huxley, and Müller for half a century represented to the world at large the oracles of their respective fields of knowledge. Yet none of the three held this position in the eyes of the inner circle of scientific workers, who, indeed, recognize no oracle, and judge their colleagues exclusively on technical grounds. The general public, on the other hand, look for the man as revealed in his general thought and especially in his style. Perhaps this judgment, though often extremely inaccurate in details, is on the whole not less just than the narrower appreciation of the scientific world. These three men well illustrate the difference in the two points of view. While not admitted to any lofty rank by his scientific brethren, Tyndall held his materials in a firm grasp and was master of a clear style and a thought behind it equally gleaming and incisive. In like manner Huxley will be remembered less as a comparative anatomist and taxonomist than as a popular lecturer and writer of books comprehended of the people, and well weighted with careful thought. Both of these men died in the full glory of popular applause, and therein they were happier than the third of this remarkable trio, for Müller's fame waned before his death, and for the last ten years no critic has been too humble to speak of him lightly in his capacity of linguist and mythologist.

THE LATE PROF. MAX MÜLLER.

But the master of a generation ago cannot be dismissed without the meed of praise due to his ability and to the work actually accomplished by him. It is true that he was at his best as an interpreter. His unrivaled style, his enthusiasm, his eloquence in a domain distinguished for arid research, made him and his field known to those who would otherwise have had no interest in the line which he represented. But is this a slight thing? There are many who owe to Müller's magnetism the first impulse to tread in the path which he opened for them; many who have been accustomed to sneer, and yet have him to thank for the ability to do so. In a word, Müller, even as a middle-man between the inner shrine and the outer world, deserves well of two generations. In his matured strength he was an inspiration, and he has always aided his chosen science by his poetic insight and suggestiveness, even when the cause for which he fought was wrong. Regarded solely from the material side, the benefit he has conferred upon Sanskrit studies in winning means for others as well as for himself to prosecute their labors, is not a small item in the score of good he must have entered to his credit.

But in point of fact, despite the unsatisfactory nature of much of his later work, Müller was by no means a mere go-between, feeding the public with grain raised by others. It is true that he was somewhat vain-glorious and not very scrupulous in the allotment of praise which should be rendered for what was done by others under his supervision. What he constantly proclaimed to be his own great work, the edition of the "Rig Veda," was in reality not his at all. A German scholar did the work, and Müller appropriated the credit for it. But, even in this case, though the judgment be true, it is harsh. The German scholar was paid for his labor, and did the best he could to circumvent Müller in getting out his editio prima. The incident is not altogether creditable to either party, but one thing is certain: there would have been no scholar doing the work at all, had not Müller started it. That his hand left the plow and he hired some one else to do willingly what he was unwilling to complete, is a matter of minor importance. Then, again, Müller's "Ancient Sanskrit Literature," published forty years ago, was an independent and thoroughly scholarly book, which has ever since held its own with the best publications in this complex field of investigation.

When, after twenty years, Müller returned to the special study of literature, from which his phonetic and mythological pursuits had withdrawn him, although the volume published under the title "India. What Can It Teach Us?" showed a marked decline in power in the body of the book, the learned appendix on the "Renaissance of Sanskrit Literature" proved that the old scholar was still there, vigorous, ingenious, persuasive. But the very circumstance that the most important part of the book was relegated to an appendix, while the main part was taken up with such bagatelles as "The Truthful Character of the Hindoos," and "Human Interest in Sanskrit Literature," was indicative of a grave change in Müller's attitude. He had catered to the public so long that scholarly work had become only of secondary consequence. For his general reputation this was a fatal error, since the very public he served repudiated him as a guide, while the scholars he had deserted, and to whom, in his eagerness to be always the first, he had been insultingly unfair, were more prone to ridicule his pretensions than to admit the genuine worth of his contributions to knowledge.

It is no time now to speak of the unhappy quarrels which disfigured the later years of Müller's life. Not only in this country, but in Germany, his bitterest enemies were those of his own household. Sanskrit scholars could not forgive the dishonesty of statement which marked his ex-parte presentation of facts, nor the maliciousness with which he pursued the objects of his dislike. But let that pass. What remains that is good? The noble edition of the "Rig Veda" and the authoritative "History of Sanskrit Literature" will perhaps abide as his most solid attainment in Sanskrit scholarship. Apart from these, as editor-in-chief of the "Sacred Books of the East," he has been instrumental in furthering, to the best of his ability, the good cause of publishing translations of the most important Oriental records. His own work in the series was slight, and the two volumes of "Upanishads" and one volume of "Vedic Hymns," translated for it by him, are of ephemeral value. Nor do the slighter volumes of text-books, which he prepared at intervals, call for special remark. They were the parerga of necessity, pot-boilers, such as no scholar loves and most must undertake.

But while this list records the more valuable of Müller's works in one field (though even here one should not overlook his adjutancy in the publication of Pali books as well as of Sanskrit), that which has really given him his widest renown has as yet been scarcely referred to. And it is surely not a small matter that a

scholar can win a hearing in two lines of research; for though all comparative philology may be generally regarded as the concomitant of Sanskrit scholarship, it should be remembered that they have no more to do with each other than have Greek and folk-lore. The "Science of Language," "Chips from a German Workshop," and other related volumes represent the middle period of Müller's career, and have perhaps had the widest influence. They were not very correct, and they were very popular, but they lighted up a dark field and encouraged research. As Müller advanced, he appears to have fallen a victim to the very factor in his mental furnishing which made his books so interesting to beginners—an imaginative and poetical way of looking at facts. He seems to have regarded words as endowed with some mysterious potency, and so he was drawn to the peculiar view which he upheld in his mythological studies and later in his "Science of Thought." Language was to him an organism. Thought was bred of words, not words of thought. And so we get the showy but too airy structure called science of mythology, and the much derided myths of the sun and dawn.

The position taken by Müller on this subject was never renounced by him, and when, but a couple of years ago, he published his "Contributions to the Science of Mythology," he reasserted his opinions with the obstinacy of desperation, for he saw clearly that in this regard the world had passed him by. But toward the end of his life, amid much frivolous writing such as his "Auld Lang Syne," published in 1899, wherein the man's egotism comes unpleasantly to the fore, he returned for his last work to that special pursuit which, it would seem, he held particularly dear, and in which, with pardonable self-esteem, he evidently thought himself peculiarly fitted to direct opinion. This was pure philosophy. Müller always pretended to speak of his other work as merely preparatory to the deeper studies of the relation of mind and matter, and in his translation of Kant's "Critique" and his own various publications on religion and philosophy he doubtless felt the greatest satisfaction. He was at heart a Vedantist, in a European sense, an idealist; and in the exposition of idealistic philosophy he believed that he was performing advanced work as well as gratifying his own tastes. His very latest book, the "Six Systems of Indian Philosophy," reveals not only his constant predilection for philosophical studies, but his inner sympathy with that great monistic system which proclaimed that all was one and that that one was God.

Of Müller's private life little need be said. Coming from Germany when but a young man, he settled in England, which he ever after made his home, living the quiet life of an Oxford scholar. The death of his daughter some years since was his first great blow, and one from which he never fully recovered, being affected by it physically and mentally. For a while his morale was shattered, but after a time, he bravely resumed the forsaken labors of his life. He was one who welcomed distinction, and he received many honors. In his death the world has lost a master perhaps more brilliant than profound, but one whose labors have not been wasted. He made no great discovery, but he was an able scholar, and did much that will endure.—For our article we are indebted to The New York Evening Post, and for our engraving to the Illustrirte Zeitung.

ROMAN MORTAR.

FROM time to time remnants of the Roman wall of London are unearthed, and some specimens of mortar have recently been analyzed for The Builder. The samples contained a number of water-worn pebbles varying in size up to 2 inches by 1½ inches. The whole of each sample including the pebbles was crushed to powder and then analyzed. From the appearance of the sand and pebbles it was concluded that unscreened river sand was employed. The lime and sand had been well mixed, for the mortar was almost entirely free from those isolated lumps of lime or lime carbonate which are an indication of faulty mixing. An analysis showed that the mortar was composed of 66 per cent. of sand, 13 per cent. of lime, 7 per cent. carbon dioxide, 4 per cent. earthy matter and 3 per cent. combined water and organic matter and similar quantities of water, silica, oxide of iron, alumina, magnesia and sulphur trioxide.

Chemically considered, the mortar is good because the proportion of lime to sand by volume is about 1 to 2. The quantity of silica soluble in sodium hydrate is high, and the proportion of clay and organic matter is very small. There is nothing mysterious about Roman mortar, as many analyses have been made of it. The Roman mortars in existence at the present day are mostly found in military or government work, which was no doubt constructed under strict supervision.

So far from being more ignorant than the Romans of the art of mortar manufacture, we possess in the fine grade Portland cement of to-day bonding material of much greater utility than anything they ever knew, and where our lime mortars are inferior, it is not the result of ignorance.

Exposition in Minas Geraes.—Minister Bryan, of Petropolis, under date of September 20, 1900, informs the Department that early next year there will be inaugurated at Belle Horizonte, the capital of Minas Geraes, under government and municipal support, a permanent exposition of the products and manufactures of that vast state, whose populations now exceeds four millions, and whose industries—mineral and agricultural—are being actively developed.

Mr. Bryan adds:

In 1899, the gold product of the State of Minas exceeded $3,000,000, an increase of $1,000,000 in value over 1898. Several citizens of Minas Geraes who are interested in promoting American enterprises have suggested, and are willing to undertake, the erection of a pavilion in which to exhibit machinery from our country at this forthcoming exposition. I respectfully recommend that our manufacturers of agricultural, dairy, electrical, and mining appliances, who desire to avail themselves of an inexpensive opportunity to exhibit their improved machinery, communicate on this subject with the United States consulate-general in Rio de Janeiro.

STEAM METERS.

THE function of the steam meter, introduced by A. Friedeberg, Berlin, is to condense and measure continuously a portion of the steam flowing through the main steam pipe. Inside a horizontal length of the main a flap-plate, hung from a horizontal axis, actuates through an internal sector and rack a conical plug valve controlling an opening in the top of the main. When no steam is being used, the plate hangs vertically and keeps the valve closed; when steam is flowing through the main, it turns the plate more or less toward a horizontal position, thereby opening the valve correspondingly, and the steam escaping through the valve is condensed in a worm. The water from the worm is either collected in a measuring tank, provided with a gage glass, or is delivered upon a bucket wheel, the revolutions of which are indicated upon a counter arranged to show the corresponding quantity of steam flowing along the main. Another meter, said to be used by the New York Steam Company, is thus described in The Foreign Abstracts: The steam flowing along the main steam pipe is made to pass upward through a vertical chamber, into which it enters at the bottom through an orifice, fitted with a conical valve of long taper, and lifts the valve in proportion to the quantity of steam passing through. The height of the lift is limited by an adjustable set screw, and is indicated by an arm, which records it by a pencil on a paper drum driven by clockwork. A piston attached to the bottom of the conical valve works in a cylinder of water forming a dashpot to check sudden oscillations of the valve.

METER FOR DETERMINING THE POWER OF EXPLOSIVES.

SEVERAL apparatus have been constructed for measuring the power of explosives, one of which, the Guttman meter, is shown in the accompanying engravings. This consists of a central portion, *a*, and the

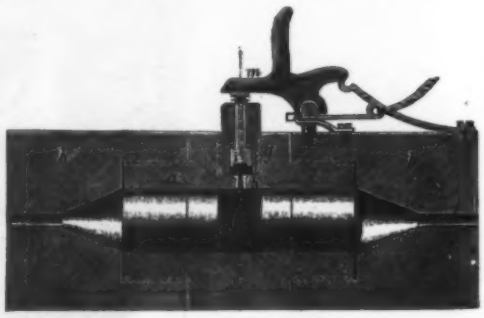


FIG. 1.—GUTTMAN'S METER.

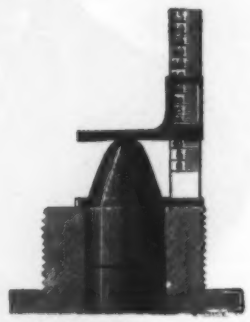


FIG. 2.—GUTTMAN'S METER—DETERMINING HEIGHT OF CONE.

head pieces, *b b*, screwed thereon and made of hardened Bessemer steel. In the apparatus are two cylinders of lead, and between these is placed about 300 grains of the powder to be tested. The hammer, *m*, strikes a little cap which causes the ignition of the powder, but the valve, *i*, is closed at the moment that the ignition takes place and prevents the escape of the powder gases, which, therefore, can act only on the leaden cylinders, forcing them a greater or lesser distance into the cones of the portions, *b*, according to the power of the powder. The height of the cones thus obtained is then measured by means of a slide gage, and this measurement is compared with the results obtained from a normal explosive, generally black powder.

For indirect explosives, such as dynamite, etc., the Tranzl test, also called the "lead test," is generally employed. In this case the explosive is placed in a leaden block of the proper dimensions, in which a bottle-shaped cavity is formed by the explosion, the volume of which is measured by pouring into it from a graduated vessel. The volume is in proportion to the power of the explosive tested.—Der Stein der Weisen.

THE BORDERS OF THE KARST.

"IF we ascend the Predil Pass from the Karinthian side, we rise above the fields of Villach to the typical landscapes of the Eastern Alps," says Prof. Cole in Knowledge for October. "At Raibi we are surrounded by the débris of the crags, and the white pebbles fill the valley floor; still climbing, through the last firwoods, we look down into the rich green Raibler See, and then up to the notch that forms the passage through the limestone crests. After that all is limestone, down to the very shores of the Adriatic; and there we approach, with a feeling of satiety, the bare white plateaux of the Karst. The learned Mojsisovics reminds us that the Karst is occasionally clothed with grass upon its summits, and with woodland on its flanks toward the sea. Anyone who has gazed upon the Karst will feel, however, that he must insist on its essential barrenness.

"The Arran Isles off the coast of Clare, and some surfaces in the west of Yorkshire, may give us an introduction to the nakedness of the Karst. In a limestone country, where storms prevail, on the one hand, or where dry seasons parch it, on the other, such soil as may be formed has little chance of preservation. The exposed surface becomes worn down along the planes of bedding of the strata. If these are gently tilted, the bare dip-slope may extend for miles; if they are horizontal, a dreary and unbroken plateau may result. Solution sets in along the prevalent joint-planes, and great open grooves arise, like the crevasses in the surface of a glacier. The water missing from the surface is found again underground, where it dissolves away the rock, and forms chains of caves and passages as it flows. As we swing down the great curves of the Predil, under the peaks of the Mangart and the Terglou, the pebbly floor assumes more and more a feature of the landscape. The vegetation on the shifting limestone surfaces becomes broken up into little clumps, and acquires the monotonous dull green tint that seems characteristic of the East. The road in summer lies inches deep in hot white dust, as the Slovenian peasant knows too well, trudging down the ravine behind his thirsty flocks. At length we emerge on the plain of Görz, where Eocene sandstones and marls lend some diversity. But there is a grim touch of the genuine Karst in the ridge that has still to be encountered, before the Italian deltas come in view."

LICORICE.

By NICOLAS PIKE.

THE order of plants Leguminosæ contains very many of our best known and most useful ones, and in it the wild weed that gives the licorice of commerce. It belongs to the genus Glycyrrhiza, though many other plants of near genera have roots that possess similar qualities. Especially is this the case with the Abrus precatorius Lin., that grows abundantly in the West Indies, notably in Jamaica, and in the islands of the Indian Ocean. It ranks over all hedges and fences with a strong, twisted, rugged stem; bears an insignificant little flower, that gives a rough pod inclosing the little scarlet seeds tipped with black so well known. When not fully ripe they are pierced and strung together to form necklaces, bracelets, rosaries, etc., frequently mixed with the larger silvery seeds of "Job's tears" (Coix lachryma). I have seen many of the colored nuns, or Sœurs de charité, counting their beads while patiently watching the couch of sick and dying sailors. The long rosaries were made of the red and white berries and the prayers marked off with sandalwood beads. The roots of the Abrus are used by all Creoles for chewing and other purposes in various bronchial ailments. They have the taste of licorice, but do not yield the rich juice of the Glycyrrhiza.

There are three species of plants, both wild and cultivated, that yield the licorice that is imported by many tons every year into the United States. They are the G. glabra, G. glandulifera and G. echinata, the latter being considered the best for cultivation. These plants grow wild in all the countries of Europe bordering on the Mediterranean, and their habitat extends through Asia Minor to Central Asia and China. England cultivates it in Surrey and Yorkshire, and the G. lepidata is said to be a native of the plains of Missouri and other similar localities in the Southwestern States.

The uses of licorice are varied and numerous. The manufacturers of chewing tobacco consume a great quantity. It serves as a demulcent for coughs and colds, and is an ingredient in many sirups and elixirs, besides having a remarkable effect in masking nauseous medicines. Porter and even ale breweries avail themselves of its saccharine, and the roots are extensively employed by them.

It is imported in different forms; in the roots, also in rolls or sticks of the dried inspissated juice that come packed in sweet bay leaves. The licorice imported into England from Calabria, Sicily, goes by the name of Solazzi or Corigliano juice; that grown in Yorkshire is made into a confection called Pontefract cakes. The roots of the licorice contain a large amount of sweet, mucilaginous juice, that owes its sweetness to a peculiar principle called glycion or glycyrrhizin, which is present in both roots and leaves. The sugar is said to be not crystallizable, and not susceptible of vinous fermentation.

The cultivation of this plant would have been arduous in former years, when there was only hand labor, and money scarce. There is now plenty of the latter article lying idle; agriculture has also made such rapid strides, and the introduction of the wonderful labor saving machines now in use for plowing, etc., would render the successful growth of the plant almost a certainty. It could then be put on the market pure, for even licorice has not escaped in this age of adulteration, as starch, rice and wheat flour, and even wood ashes, have been used for this purpose. I have carefully collected every available information on the subject, and its growth and cultivation in Europe. I give it for the benefit of those willing and able to introduce fresh objects of commerce, to utilize lands good for no other purpose, and to give profitable employment in the gathering season to numbers of willing but often idle hands.

I will first speak of the licorice a native of Southern Europe. The qualities in different countries vary greatly. It is said that the juice from Turkey and Greece is bitter, of Sicily and Spain sweet and rich, but that of Italy the richest, though less is exported thence. I am not aware of licorice being cultivated in any of these countries, as it is so vigorous and abundant a wild plant, almost too much so in many places. In Spain it grows finest in the rich bottom lands of the great rivers, and the crop depends much on the mildness or severity of the winters. It is of such vigorous growth that other weeds cannot encroach on it and crowd it out, and no parasite or insect pest is known to infest it. It is so tenacious of life that if only a small portion of the root is left in the ground after the collecting season, it shoots up again. There are two kinds of licorice, one sending down a tap root from 3 to 6 feet deep, and the other runs under ground from 6

inches to 2 or 3 feet. The latter is the most highly prized, from the facility with which it is dug up. Only the roots are used, the tops being burned for fuel. It varies in quantity and quality according to soil in different provinces, changes its color to red, yellow or brown, and the proportions of saccharine and starch vary also. The climate best suited to the growth of licorice is that where oranges and all the citrus family thrive, as it cannot endure severe ground frosts nor cold high altitudes.

In Sicily it grows most luxuriantly in low lands adjacent to streams of water. The valley of the river Simeto is so rich that, with the rudest tools and culture, the peasants have no difficulty in growing cereals and other plants for food. Their principal trouble is keeping down the weeds that spring up so abundantly in the cultivated lands, and the licorice from its pertinacity is most dreaded. A farmer when asked if it grew on his farm replied, "God forbid! for of all wild vegetation, it is most difficult to subdue." A crop can be gathered every three or four years from the same ground, and the digging commences after the autumn rains have set in. Licorice requires the hot sun to perfect its juice, but at the same time it bakes the ground so hard, the task of collecting the deep-set roots would be too laborious and expensive till the earth is well saturated. There are seven manufactories in Catania alone, and they produce from 700,000 to 800,000 pounds annually, and others in various cities of the island. Very little of the root is exported either from Sicily or Italy, only the rolls or sticks made from the inspissated juice. Asia Minor exports largely to the United States, mostly in sailing vessels under the Austrian and Italian flags. A great deal of the trade in this country is in American hands. So long ago as 1885, steam presses were in use there, and from Alexandreth, in Smyrna, 6,000 tons were exported at a value of about $192,000.

Licorice has been cultivated in England since about the fourteenth century. It is said to have been imported from Germany (a fact I doubt from its climate), and was cultivated in the gardens of the old monasteries. The monks, I presume, introduced this plant as they did so many other useful ones, as it entered very largely into their medicaments. There were in a measure the guardians of the poor in their vicinity in those days, and dispensed medicines for the cure of their bodily ailments, equally with their care for their souls. Licorice has been so successfully cultivated in England that I give the methods employed, as they would, I should think, serve well for our own country.

Mitcham, in Surrey, has been famous for its "herb farms" for over a century, and the air is redolent in summer and autumn with the delicious perfumes of lavender, thyme, rosemary, chamomile, peppermint, and other plants used in medicines or for distillation. The soil is a deep black mould, with some admixture of sand, and considerable licorice has been grown here. The plant is graceful, with feathery pinnate foliage, grows about two or three feet high, and bears small whitish yellow flowers. Since licorice has been imported into England duty free, the crops have been less attended to, as other plants pay better.

Near Pontefract, Yorkshire, it has been long successfully cultivated. The soil is a sandy loam, and has to be of considerable depth to allow the roots to develop well. The beds are prepared by being well trenched, the width of trench and bed averaging three feet, and having the appearance, when finished, of wide celery beds. Commencing early in April or late in March, a top dressing of stable manure is applied and lightly covered over, leaving the trench about six inches below the raised bed. Holes are made with a small spud a few inches apart, and another person follows (often a girl) with a basket of buds and suckers, slips or runners, and they are inserted about four inches below the surface and covered to that depth. This forms a double crop, that is, the buds grow downward, producing the roots, and the suckers form buds for future planting, the width of the beds permitting of cross rows of plants. The buds and suckers are left in the ground for three and a half years, a crop being obtained in the September following the fourth spring. The first manuring is sufficient, the plants being weeded each summer. A hot, dry season is best for them; they need no irrigation even in the hottest weather, and are free from all insect pests.

The trenches are of course idle for two years, as the plant tops do not show much in that time, so potatoes are planted in them the first year. A species called ash potatoes is used, as they have such small tops they do not overshadow the young licorice plants as larger kinds would.

The second year a crop of cabbages is grown, but the third year the trenches must lie fallow, as the licorice then shows luxuriant growth, and presents in the summer the appearance of a shrubbery of young ash trees. The grower plants a fresh crop every spring of each year, and in autumn harvests the one of three and one-half years' growth.

The only labor required is that the beds be kept clear of weeds in summer, and in November, when the sap is down, the plant tops must be cut off. If the winter proves unusually severe, the tops can be covered with a light layer of earth.

TO GATHER AND PREPARE THE ROOT.

The trench, not the bed, must be dug down to a considerable depth, thus exposing without injuring the roots, and the whole plant is very carefully taken out of the ground. The earth from the second trench is then thrown into the first, and so on to the end of the field. The roots are then placed in dry cellars after removing the tops and suckers and often covered with sand. The latter serve for the next spring's crop to produce "buds," that is, roots in their early stage for another year. When the stored roots are dry, they form the yellow licorice for producing the juice of commerce. A small portion of the top of the root is cut off as being of less value than the rest, and is ground into powder and sold to chemists for various uses. The tops are only good for burning.

The three and a half years' sucker, which is gathered with the licorice plant, has now produced "buds," which are reserved with the new suckers for planting. They are either stored in a cellar and covered with rotten dung, or they are made into a mound, outside, and well buried in earth or moist sand, and thus withstand the cold, wet winters of Yorkshire.

There appears to be considerable difficulty in finding out some of the first processes of the manufacture of licorice. Mr. Hilliard, who has the largest factory in Pontefract, courteously shows the place to visitors, with the above reservation.

In Sicily, when the roots are dug up, they are bound in bundles and stored in the factories for some time to season them. When sufficiently cured, men and women cut them into short pieces, and then they are plunged into a vat of water, and thoroughly washed; they are then crushed in a rude mill, which consists of two circular stones of lava, the one horizontal, the other perpendicular over it. Through the center of the upper stone is an axle, to which is attached a mule, which revolves it slowly in a circle. When sufficiently crushed, they are boiled in water for 24 hours, then removed from the kettles and placed in a screw press, and the juice squeezed out into a cistern beneath. It is passed through a sieve and again boiled, and the sediment again pressed, and the whole again filtered. When boiled to a certain consistency, it is placed in pans over a fire, and men stir it till dense enough for paste. It is placed in wooden moulds for cakes, or made into rolls or sticks, which when dried are packed in bay leaves for exportation. When the roots are required, women scrape off the bark, cut it in the desired length, and when dry it is packed in bags, great care being taken they do not mould nor freeze, and they must be free from the least blemish.

In England now the greater part of the juice manufactured is from roots grown in Spain and Sicily, as the English ones are of smaller size. As the passage is so rapid now over the ocean, a package of roots, buds or suckers could be brought as fresh and easily, perhaps more so, than from one of our own Western States, and doubtless from the greater heat here they would improve in size. It would not be difficult to procure fresh wild roots and buds direct from Spain. There is direct intercourse with Seville, whence licorice is shipped to England by steamers or by sailing vessels direct to America. An ordinary Wardian case could be sent to Seville and would bring back roots and buds enough to start a licorice farm.

Allowing for the difference of climate in England and the United States, anywhere south of Washington, D. C., ought to produce licorice of fine quality with careful culture. There are plenty of low-lying lands good for nothing else that could be permanently profitable for it, where ground frosts are light. I say ground frosts, because there is no leafage in winter to be injured. The average latitude where licorice flourishes near the Mediterranean is from 36° to 41° N. lat., in Mitcham, Surrey, 57° 30', and in Pontefract, 53°.

CONDENSED INFORMATION CONCERNING SOME OF THE MORE VALUABLE INSECTICIDES.

KEROSENE EMULSION.

THIS insecticide acts by contact and is applicable to all non-masticating insects (sucking insects, such as the true bugs and especially plant lice and scale insects) and also to many of the mandibulate insects when the use of arsenites is not advisable. Kerosene emulsion may be made by means of various emulsifying agents, but the most satisfactory substances and those most available to the average farmer and fruit grower are milk and soapsuds. In each of these cases the amount of emulsifying agent should be one-half the quantity of kerosene.

One of the most satisfactory formulas is as follows:

			Per cent.
Kerosene	2	gals.	67
Common soap or whale oil soap	½	lb.	33
Water	1	gal.	

Heat the solution of soap and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens upon cooling and should adhere without oiliness to the surface of glass. For use against scale insects dilute one part of the emulsion with nine parts of water. For most other insects dilute one part of the emulsion with fifteen parts of water. For soft insects like plant lice the dilution may be carried to from twenty to twenty-five parts of water.

The milk emulsion is produced by the same methods as the above.

THE RESIN WASHES.

These insecticides act by contact, and also, in the case of scale insects, by forming an impervious coating which effectually smothers the insects treated. These resin washes vary in efficacy according to the insect treated. Experience has shown that the best formula for the red scale (Aonidia aurantii Maskell) and its yellow variety (A. citrinus Coquillett) is as follows:

Resin	18	lb.
Caustic soda (70 per cent. strength)	5	"
Fish oil	2½	pts.
Water to make	100	gals.

The necessary ingredients are placed in a kettle and a sufficient quantity of cold water added to cover them; they are then boiled until dissolved, being occasionally stirred in the meantime, and after the materials are dissolved the boiling should be continued for about an hour, and a considerable degree of heat should be employed, so as to keep the preparation in a brisk state of ebullition, cold water being added in small quantities whenever there are indications of the preparation boiling over. Too much cold water, however, should not be added at one time, or the boiling process will be arrested and thereby delayed, but by a little practice the operator will learn how much water to add so as to keep the preparation boiling actively. Stirring the preparation is quite unnecessary during this stage of the work. When boiled sufficiently it will assimilate perfectly with water, and should then be diluted with the proper quantity of cold water, adding it slowly at first and stirring occasionally during the process. The undiluted preparation is pale yellowish in color, but by the addition of water it becomes a very dark brown. Before being sprayed on the trees it should be strained through a fine wire sieve, or through a piece of Swiss muslin, and this is usually accomplished when pouring the liquid into the spraying tank, by means of a strainer placed over the opening through which the preparation is introduced into the tank.

The preparing of this compound will be greatly accelerated if the resin and caustic soda are first pulverized before being placed in the boiler, but this is quite a difficult task to perform. Both of these substances are put up in large cakes for the wholesale trade, the resin being in wooden barrels, each barrel containing a single cake weighing about 375 pounds, while the caustic soda is put up in iron drums containing a single cake each, weighing about 800 pounds. The soda is the most difficult to dissolve, but this could doubtless be obviated by first dissolving it in cold water and then using the solution as required. This insecticide may be applied at any time during the growing season.

A stronger wash is required for the San José scale (Aspidiotus perniciosus Comstock), and the following formula gives the best results:

Resin	30	lb.
Caustic soda (70 per cent.)	9	"
Fish oil	4½	pts.
Water enough to make	100	gals.

Place all the ingredients in a kettle and cover with water to a depth of 4 or 5 inches, boil briskly for about two hours or until the compound can be perfectly dissolved with water. When this stage is reached, the kettle should be filled up with water, care being taken not to chill the wash by adding large quantities of cold water at once. It may be thus diluted to about 40 gallons, the additional water being added from time to time as it is used.

This preparation should only be applied during winter or during the dormant period. Applied in the growing season, it will cause the loss of foliage and fruit.

In the application of both these washes, a very fine spray is not essential, as the object is not simply to wet the tree, but to thoroughly coat it over with the compound, and this can be best accomplished by the use of a rather coarse spray, which can be thrown upon the tree with considerable force.

FOR SUBTERRANEAN INSECTS.

Recent experiments have shown the practical value of the resin compounds against the grape phylloxera, and they will also be applicable to the apple root louse and other underground insects. The cheapest and at the same time one of the most satisfactory compounds experimented with is the following:

Caustic soda (77 per cent.)	5	lb.
Resin	40	"
Water to make	50	gals.

Dissolve the soda over fire with 4 gallons of water, add the resin, and after it is dissolved and while boiling, add water, slowly, to make 50 gallons of compound. For use, dilute to 500 gallons. Excavate basins about the vines 6 inches deep and about 2 feet in diameter, and apply to each vine 5 gallons. The results will be more satisfactory if the treatment is made early in the spring, so that the rain of the season will assist in disseminating the wash about the roots.

The kerosene emulsion made according to the formula given above is also applicable to certain underground insects in cases where it will not prove too expensive, as, for instance, the grape phylloxera or where white grubs are infesting a valuable lawn. It may then be used in the proportion of 1 part of the emulsion to 15 gallons of water, applied liberally to the soil, and afterward washed down at frequent intervals with large quantities of water for several days. This can be done only where there is plenty of water at hand, but will be found of great value in special cases.

In other cases bisulphide of carbon may be used for specific and local underground forms. Nests of ants, for instance, may be destroyed by pouring an ounce of this substance into several holes, covering them with a wet blanket for ten minutes and afterward exploding the vapor at the mouth of the holes with a torch. Against onion, cabbage, and radish maggots this substance may also be used, by punching a hole with a sharp stick at the base of the plant and pouring in a teaspoonful of the liquid, covering afterward with earth.

THE ARSENITES—LONDON PURPLE, PARIS GREEN, AND WHITE ARSENIC.

These poisons are of the greatest service against all mandibulate insects, as larvæ and beetles, and they furnish the most satisfactory means of controlling most leaf feeders and the best wholesale remedy against the coddling moth. Caution must be used in applying them on account of the liability of burning or scalding the foliage.

The poisons should be thoroughly mixed with water at the rate of from 1 pound to 100 to 250 gallons water and applied with a force pump or hand spray nozzle. In preparing the wash it will be best to first mix the poison with a small quantity of water, making a thick batter, then dilute the latter and add to the reservoir or spray tank, mixing the whole thoroughly. When freshly mixed, either London purple or Paris green may be applied to apple, plum, and other fruit trees, except the peach, at the rate of 1 pound to 150 to 200 gallons, the latter amount being recommended for the plum, which is somewhat more susceptible to scalding than the apple. White arsenic does little if any injury at the rate of 1 pound to 50 gallons of water. As shown by Mr. Gillette, however, when allowed to remain for some time (two weeks or more) in water, the white arsenic acts with wonderful energy, scalding when used at the rate of 1 pound to 100 gallons from 10 to 90 per cent. of the foliage. The action of the other arsenites remains practically the same, with, perhaps, a slight increase in the case of London purple.

With the peach these poisons, when applied alone, even at the rate of 1 pound to 300 or more gallons of water, are injurious in their action, causing the loss of much of the foliage.

By the addition of a little lime to the mixture, London purple and Paris green may be safely applied, at the rate of 1 pound to 125 to 150 gallons of water, to the peach or the tenderest foliage, or in much greater strength to strong foliage, such as that of the apple or most shade trees.

Whenever, therefore, the application is made to ten-

der foliage, or when the treating with a strong mixture is desirable, lime water, milky, but not heavy enough to close the nozzle, should be added at the rate of about 2 gallons to 100 gallons of the poison.

Pure arsenic, however, should never be used with lime, as the latter greatly increases its action.

With the apple, in spraying for the codling moth, at least two applications should be made—the first on the falling of the blossoms, the apples being about the size of peas, and the second a week or ten days later; but the poison should never be applied after the fruit turns down on the stem, on account of the danger of the poison collecting and remaining permanently in the stem cavity.

For the plum curculio on the plum, cherry, peach, etc., two or three applications should be made during the latter part of May and the first half of June; in the case of most leaf feeders, spray on the first indication of their presence.

CAUTION NECESSARY IN THE USE OF THESE INSECTICIDES.

The relative susceptibility of apple, plum, and peach has just been indicated under the head of arsenical poisons, and these remarks apply equally well to the use of the kerosene emulsions. In the case of other plants thorough experiments are still necessary, and all insecticides should be first used in comparatively high dilution. In general, it may be said that tender young foliage is more susceptible and must be carefully treated. Thin-leaved pilose plants are more readily injured, while thick-leaved, glabrous species are least affected. Annual plants, such as cabbages, and other garden vegetables, are more susceptible than perennials, but in the case of root crops, such as beets, turnips, radishes, and potatoes, there is not the same need of caution as to the damage to foliage. Damage to foliage is not shown at once, and in case of rain following an application, another application should not be made for several days. Fruit trees should not be sprayed with arsenical poison before the blossoms fall, on account of the danger of poisoning honey bees.—Circular U. S. Depart. Agricul.

TEA PRODUCTION IN INDIA.

THE area under tea in India has extended in the last fifteen years without a pause. In 1885 the acreage was 283,925, in 1890 it had risen to 344,827, and in 1895 to 415,717, while at the end of 1899 the area stood at 516,732 acres. In the last five years the average annual addition was 23,341 acres, against 13,365 acres in the preceding quinquennium, the chief additions being in 1897 and 1898. Of the total area cultivated in 1899, there were 198,673 acres in Assam (the Brahmaputra valley), 132,478 acres in Cachor and Sylhet (the Surma valley), 132,923 acres in Bengal, and 23,103 acres in Travancore. The area taken up by planters, but not yet planted, was 957,105 acres at the close of 1899. Tea cultivation is mainly centered in tracts where a heavy rainfall and a humid and equable climate permit of repeated flushes and pluckings of the leaf. In the Brahmaputra and Surma valleys the yield averages about 448 pounds per acre, while in the Duras and Darjiling (both in Bengal) the yield is 533 pounds and 281 pounds per acre respectively.

The plantations vary greatly in size. In Assam, where Europeans with ample capital carry on the industry, and where economy of management has led to the fusion of tea estates, a plantation averages 1,266 acres, while in Bengal the average is only 727 acres. In the Kangra valley of the Punjab, where natives grow tea, there are only about four acres to each plantation. The quantity of tea produced in the past fifteen years has increased in much greater ratio than the cultivated area, for while the area has increased by 82 per cent., the production has risen 161 per cent. The quantity produced in 1899 was 186,500,000 pounds, or nearly 23,500,000 pounds greater than the production in 1898.

The number of people permanently employed in the tea industry was 558,000 in 1899, besides an average of nearly 100,000 temporary laborers daily employed. Comparatively little tea is consumed in India itself. The Indian consumption consists of about 8,000,000 pounds, of which 2,750,000 pounds is foreign (mainly Chinese). Taking an average of the last five years, we find that India has produced 160,644,000 pounds and exported 155,474,000 pounds. The United Kingdom has taken no less than 97 per cent. of the average production. The exports in 1899–1900 were as follows: United Kingdom, 154,161,000 pounds; Australia, 8,363,000 pounds; North America, 4,678,000 pounds; Persia, 1,953,000 pounds; Russia, 467,000 pounds; and countries on the northwest frontier of India, 2,101,000 pounds. The prices of tea fluctuate greatly.

THE WOLF-SPIDERS.

THE Lycosæ, or wolf-spiders, are so called because they pursue their prey and force it to run, as does the sanguinary carnivore the wolf. They are found nearly everywhere during the summer season, along roads, upon grassy slopes that border ditches, and in marshes, etc. They swarm especially in places upon which the sun sheds its most ardent rays. Perhaps, however, they would not manifest this predilection were it not that it is in precisely such localities that the insects upon which they feed are accustomed to congregate.

At the beginning of summer, the promenader who wanders over the shady paths upon which dead leaves have accumulated during winter will start up myriads of Lycosæ, which will trip along in haste toward some safe retreat. These spiders are always easily recognized at first sight by their jerky gait and their abrupt motions, which are sometimes so precipitate that the animal seems to displace itself by a series of somersets.

The Lycosæ, which are of medium size, are covered with dark hairs, often ornamented with light rings. As they are essentially wanderers, they do not spin vast silken hammocks, or geometrical webs or traps for catching unwary flies. The wolf-spiders, in fact, are nomads, having no home instincts, but camping every night in some place selected at hazard during their peregrinations. They are the proletarians of the octopod tribe, in which the individual must be very poor indeed that has not a dwelling to shelter him. They show no tendency to lie in ambuscade, and cannot expect to be fortunate enough to have their prey fall under their fangs through its own imprudence. When their appetite, sharpened by their journeys, makes itself felt, they are obliged to go on a hunt, and in such cases have recourse to strength rather than to cunning in order to obtain the living prey that they desire. Their tactics are reduced to a few elementary principles showing merely the simplest prudence. Like the cat, they know how to deceive the vigilance of their victim by the calculated slowness of their motions and to leap only in dead earnest; the space that separates them from the victim being crossed in three quick jumps. Very courageous in these attacks, they unhesitatingly contend with insects larger than themselves. They are, it is true, well equipped for success, and can rely upon their venomous fangs as an infallible resource. But we nevertheless have to admit that they have some energy when we see them attack large flies, which, at the first onset, fly away in an impetuous whirl in carrying along the little lycosa, which never lets go its hold.

Although they do not know how to manufacture

FIG. 1.—LYCOSÆ OR WOLF-SPIDERS.

To the left is seen a female dragging her egg bag and to the right a female carrying her young upon her back.

webs and traps, they are, nevertheless, capable of emitting silk from their spinnerets. Vast nets of such filaments are seen hanging over the neglected fields in autumn. Upon a fine day in which the air is agitated by a slight breeze, the silver threads gently rise and float over the plains; and sometimes, fastened to the silken clew, we find a young lycosa, which this balloon of a primitive type is carrying to a distance.

Spiders usually inclose their eggs in a cocoon, which they watch and protect until the young are hatched and capable of taking care of themselves. Such a thing would not suit the lycosa, which is incessantly on the move, so she gets round the difficulty as follows: After she has laid her eggs, she places them in a globular bag which she secures to her spinnerets and carries around with her wherever she goes. When the young emerge from the shell, she receives them upon her back and watches over them until they

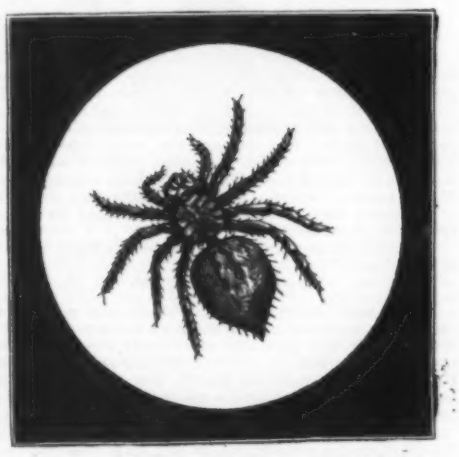


FIG. 2.—A RECENTLY HATCHED LYCOSA.

(Greatly magnified.)

are old enough to provide for themselves.—For the above particulars and the engravings we are indebted to La Nature.

TROPICAL HURRICANES.*

By F. J. B. CORDEIRO, Surgeon United States Navy.

THE Caribs, who dwelt in the West India Islands long ago, before the coming of the white man, had a word in their tongue which has come down to us and passed into many languages. It is "Hurakan." In the China Seas they speak of a "Typhoon." The Samoans have their own word for it, and so on through every tropical country. These words all mean in the original a mighty wind, and refer to the same phenomena.

Now that we have possessions in the West Indies, our attention has been called especially to that peculiar and complicated storm known as the tropical cyclone. For the first time American soil has been swept by its full fury, and our weather observers who have during the past year been distributed around the Caribbean Sea have had an opportunity of chronicling, if not the most severe, yet probably one of the most destructive storms that has ever visited these regions. During the past 300 years, 355 such hurricanes have been recorded; but these were only those of exceptional severity. It is as mathematically certain as the laws which govern them that they will continue to recur on an average of several every year, as long as the West Indies exist. It is interesting to conjecture here what would have been the result had Columbus encountered one of these storms on his first voyage of discovery. Had he passed through the "eye" of a severe hurricane, it is extremely doubtful if his frail caravels could have weathered it, and the discovery of the new continent must have been delayed many years.

The hurricane of August 7, 8, 9, 1899, was like all others, differing only in degree. The author was on the southern coast of Santo Domingo at the time. Early on the morning of the 7th, long, heavy swells began coming in from the eastward, which was the method the storm used to telegraph its approach.

As these long ocean waves may travel with a velocity of 80 or even 100 miles an hour, while the storm itself seldom travels more than 20 miles an hour, it will be seen that its arrival may be anticipated a day or more in advance. In the afternoon of the 7th a telegram was received from Washington saying that a hurricane somewhere to the eastward of Dominica was approaching that island in a westerly and somewhat northerly direction. If there had been any doubt as to the meaning of the long swells coming from the eastward, all was now clear. The probable course of events could be forecast as follows—not from any special knowledge regarding cyclones (for our knowledge as to their laws has been hitherto singularly deficient), but because year after year they carry out the same programme, almost without variation. The wind would blow from the eastward of north, through north to southwest; the barometer would progressively fall, afterward rising to about its original level. The track of the storm would be to the westward and northward. It would pass over Porto Rico by Turk's Island, sweep the Bahamas, and recurving somewhere about latitude 30°, would roll up the coast of the United States and out to sea, and then finally be dissipated. In the wake of the "Freight Train" the afterswirl would follow, and a persistent southeast wind could be expected. Martinique, Guadeloupe, St. Thomas, Montserrat, Porto Rico, Santo Domingo, and the Bahamas would be likely to suffer more or less damage according to the severity of the cyclone. And we know now that all this is what practically took place.

What the battering-ram effect of wind striking with a velocity of 80, 100, 125, or even 150 miles an hour is, and what the inundating effect is of the tremendous precipitation caused by cyclones, and of the tidal waves which the low center may carry along, we have lately seen and have seen many times in the past. The hurricane of October, 1780, called the Great Hurricane, was very similar to the recent one in many respects. While the loss of life in Porto Rico was appalling, it cannot be compared to the loss caused by the cyclone at Barisal and Backergunge, in India, in June, 1822, when more than 50,000 lives and a vast amount of property was destroyed. The West India hurricane of August, 1873, killed more than 500 people, damaged, stranded, or wrecked more than 1,000 vessels, besides doing an enormous amount of damage to buildings on shore. Such is the terrible and extraordinary interest these phenomena possess for us.

It will be interesting to attempt to trace the course of a hurricane from its birth to its end. It must be premised that the sun, in its course round the earth day after day, heats a broad zone of the atmosphere directly under it. The air, becoming rarefied by this excessive heat, rises directly upward, very much like the hot air in a flue. This zone is known as the doldrums, and is about 10° wide. From the north and the south surface currents of cold air rush in to fill this void, which, owing to the revolutions of the earth from west to east, gives a northeasterly direction to the wind coming from the north and a southwesterly direction to the wind coming from the south. When the sun is to the south of the equator, a corresponding state of affairs exists, the doldrums being bordered by the southeast trades on the south and by the northeast trades on the north, which become northwesterly after crossing the equator. These so-called trade winds, with the interlying zone of doldrums, follow the sun north and south of the equator. A tropical cyclone always originates in the doldrums, and it may start over land or sea. If the surface of the earth were covered with water alone, it would be difficult to see how a hurricane could arise, since, the conditions being uniform everywhere, there would be no determining point from which it could take its origin. With land scattered about it is a different matter. Since the specific heat of water is much greater than that of land, the heat pouring down from the sun raises the underlying islands to a much greater temperature than the surrounding water during the day, and since during the night the land cools more rapidly, we have generally a "low" over an island during the day and a "high" during the night, which give rise to the sea breeze of the day and the land breeze of the night, so well known in the tropics. It is easy to see how a "low," arising over a sufficiently large island, could give rise to a very respectable cyclone.

Where, as in the recent cyclone, the "low" originated on the sea (to the eastward of Dominica), it is possible that a cause lay in the great ocean current coming up along the coast of South America, or a heavy precipitation of rain at this point freeing a vast amount of latent heat, and, by relieving the atmosphere of the pressure of a large amount of aqueous vapor, causing a diminution in the pressure that started the phenomenon. It seems hardly necessary to speculate further on how "lows" of unusual dimensions may be formed—on the contrary, it seems wonderful that they are not formed oftener.

However that may be, we will simply suppose that a barometrical depression of unusual proportions occurs suddenly at some point. The wind from all surrounding points immediately begins to rush toward the vortex. Since the air in the doldrums is usually calm, it must have the same revolutional velocity as the part of the earth over which it lies. Consequently, all the

* Published in the Bulletin of the Geographical Society.

air coming from the southward will be deflected to the eastward of the center, and all the air coming from the northward will be deflected to the westward, and a whirlwind will be formed which must revolve contra-clockwise. It will easily be seen that this is a general law for the northern hemisphere, viz., that every "low" in the northern hemisphere must result in a contra-clockwise vortex, while every "low" in the southern hemisphere must cause a clockwise vortex. Conversely, every "high" in the northern hemisphere must cause a clockwise whirl, while the opposite is true for the southern hemisphere.

We have, then, a phenomenon the counterpart of which is seen in the water flowing out of the drain-pipe of a bath tub; or, more exactly, in the whirl of leaves on a gusty autumn day; or in a water-spout, which is a miniature cyclone.

Our cyclone is now formed. Before it starts off on its journey, let us survey it carefully.

The diameter of a cyclone may be anywhere from 100 to 1,000 miles, and its height from 20 to 40 miles. As the air is drawn in by a central attracting force, it follows approximately the so-called laws of equal areas, viz., a line connecting a given mass of air with the center will describe equal areas in equal times. The general form of the whirl is as shown in Figs. 1, 2, and 3, Fig. 1 being a vertical view, and Figs. 2 and 3 being horizontal projections.

It will be seen that a portion of air moving with comparative slowness at first, as it falls into the outer edge will gradually increase in velocity until it reaches

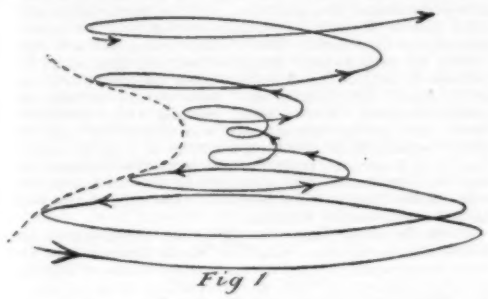


Fig 1

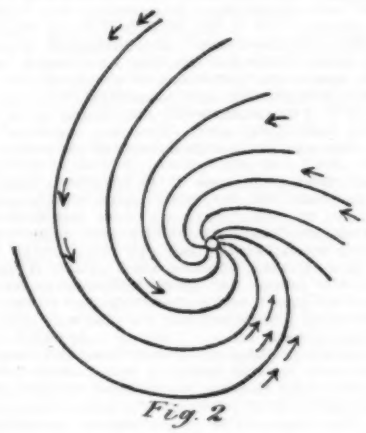


Fig. 2

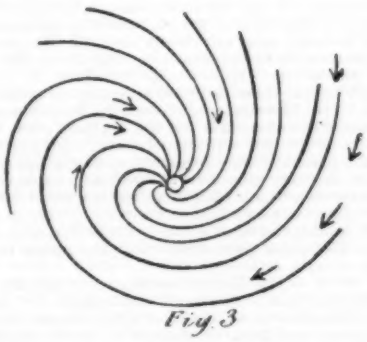


Fig. 3

the narrowest part of the "hour glass," which is some distance above the surface of the earth.

The highest surface velocities are not far from the axis and are usually 80 to 100 miles an hour—a force which few objects can withstand. It will be seen from Fig. 1 that "axis of the storm" is a more correct term than "storm center." The barometrical pressure across such a cyclone can be well seen by examining the accompanying pressure gradient. It will be noticed that we have come to speak of our cyclone as an entity by itself, totally different from the surrounding air. Since its parts preserve their distances and relative relations, it may, for all intents and purposes, be regarded as a solid body of equal mass rotating with its average velocity. This does not mean that the same air always constitutes the same cyclone, for such is not the case. The identical particles of air that caused so much change in Porto Rico are not transported to the Bahamas to continue their work there. On the contrary, this air, after having been "through the mill," is left high above the earth not far from where it was originally derived. It is like a rotary snow-plow, where, though the mass in rotation is constantly changing, still an average energy of rotation is preserved.

The most important question of all from every point of view, both practical and theoretical, now awaits us, viz.: Why does the cyclone move and what are the laws governing this motion? Up to this time this part of the problem has been considered inexplicable. It will be seen that if the laws governing revolving storms (and all storms are revolving) were understood, and this knowledge could be applied to predicting their paths, meteorology would advance with one bound from scientific guesswork to an exact science. If the path of a cyclone can be predicted from its "elements" with the same accuracy as the path of a comet, then the science of meteorology acquires a dignity commensurate with that of astronomy. I believe this point has been reached. Given a cyclone with a known "moment of inertia," of a known mass, rotating with a mean angular velocity at a given latitude and longitude, and its path and subsequent motion may be determined. The importance of this knowledge to all regions lying in the track of the cyclone is evident.

Let Fig. 6 represent a section of the earth through its axis, and C a cyclone at the extremity of the radius, $O\,C$, rotating in the northern hemisphere contra-clockwise. Since the radius, $O\,C$, rotates with the angular velocity of the earth, our cyclone may be regarded as an ordinary gyroscope. As the average velocity of the air of which the cyclone is formed is that of the surface of the earth under its axis, we may consider merely the motion of a gyroscope, $O\,C$, moving about a fixed point, O, or an imponderable axis, $O\,C$.

It is not the intention of the author to give the complete analysis of the motions of a gyroscope under the given conditions, since this is professedly a popular article. The object is simply to elucidate the subject to the non-mathematical mind.

To the reader with a slight knowledge of mathematics, it will be sufficient to say that the gyroscope is an instrument that develops a deflective force normal to the plane in which it is turned. For instance, if our cyclone is turned with the earth, it will develop a deflective force, tending to increase its latitude, and a certain velocity will be developed toward the pole.

This velocity likewise will develop deflective force, tending to increase its longitude.

Let x represent the longitude and y the latitude of

Fig 4

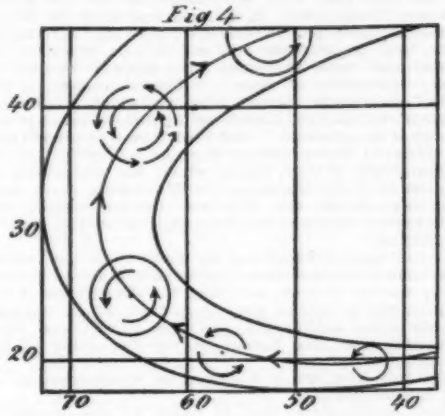
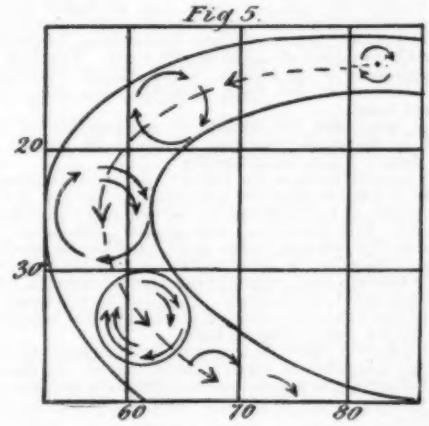


Fig 5.



the axis, and suppose an initial impulsive velocity equal to the velocity of the earth at the point to be given to the cyclone. Considering only a portion of the spherical surface small enough to be regarded as plane, we have as the equations of motion:

$$\left(\frac{d^2y}{dt^2} = k\frac{dx}{dt} \;\&\; -\frac{d^2x}{dt^2} = K\frac{dy}{dt}\right)$$

since the normal deflecting force is proportional to the angular velocity. Integrating these equations, we get as the curve of motion $x^2 + y^2 - 2\frac{Vo}{k}y = 0$, which is the equation of a hyperbola situated vertically, with the origin at the upper vertex. It may be remarked that k above is equal to $\frac{CW}{RM}$ where R is a radius of the earth, and C, W, and M are respectively the moment of inertia about the axis, the angular velocity and the mass of the cyclone.

It will be seen, therefore, that if the earth were at rest, and the cyclone given an initial velocity equal to its actual rotational velocity and started from a point, P, it would describe the curve, $P\,H$, which is for a small surface a hyperbola, as drawn in the figure with P the initial point at the vertex. Since no work is done, the living forces must remain constant. Therefore

$$\left(\frac{dx}{dt}\right)^2 \mathrm{Sin}^2\,\theta + \left(\frac{d\theta}{dt}\right)^2 = \mathrm{Const.}$$

In other words, the gyroscope or cyclone will travel in the curve with a constant velocity equal to that originally impressed upon it. To obtain the actual path of the cyclone, we must compound the above motion with the motion of the earth about the axis. It is readily seen that the cyclone, starting out with the same velocity as the point of the earth on which it rests, gradually lags behind and goes to the northward. As it moves in the right-hand branch of the hyperbola, $P\,H$, it finally reaches a point where its velocity is equal to that of the earth. Here it stops going to the westward; shortly beyond its velocity becomes greater than that of the earth, owing to the diminishing circles of latitude. Here it moves to the eastward, but during the whole of its motion continually makes northing. The arm of the hyperbola being regarded as a straight line, which it may nearly be, it will be seen that the velocity to the northward is tolerably constant, while the velocity to the westward is constantly retarded and that to the eastward constantly accelerated; so the curve of the cyclone on the earth's surface must closely resemble a parabola, with the axis east and west. It is well known that a body moving with a constant velocity in one direction and with a constantly accelerated or retarded velocity in a direction at right angles must describe a parabola—a projectile, for instance. And such, in fact, do we find to be the actual paths taken by cyclones. The above is a rigidly exact explanation of the path of a cyclone, which has been a sore puzzle ever since it was first observed. Compare the paths delineated in Chart I. and II. from Piddington's Sailor's Hornbook. It will be seen that these paraboloid curves all have in-

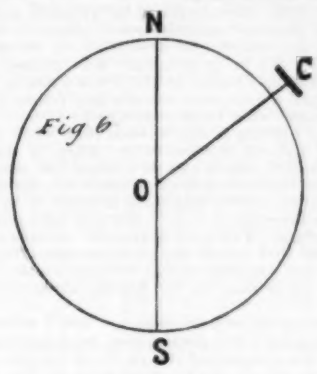


Fig 6

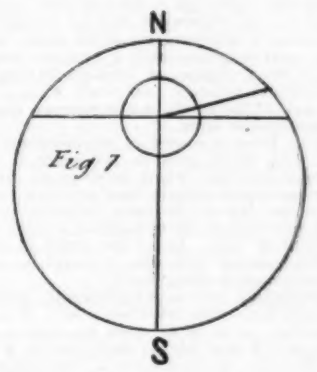


Fig 7

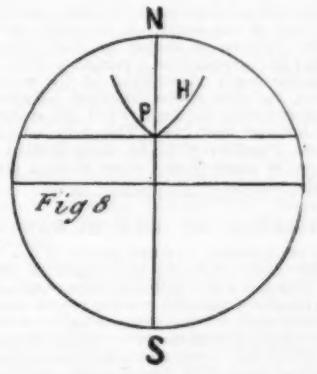


Fig 8

dividual differences, depending upon differences in C, W and M, and the latitude and longitude where they started. That the path can easily be calculated from the "elements" is now clear. The meridian where it will recurve, its velocity at any point, and in fact anything about its subsequent motion, can be predetermined. As to its velocity, it will be seen that if the generating hyperbola is very broad, so that the branches tend to coincide with the parallel of latitude on which it rests, the velocity may be very slow, but it never can be stationary. Some authors have spoken of stationary cyclones. Mathematical analysis shows that such a thing is impossible. When the branches are very narrow, there may be a high velocity. As a matter of fact the observed velocities have ranged from 3 to 50 miles an hour or even more.

It remains to explain the observed broadening out of cyclones as they progress. This is on the same principle as a snowball increases in size by rolling. They are rolling stones that gather moss. The tendency of this is to destroy the original motion of rotation and lead to their dissipation. This is further helped along by friction on the surrounding air and on the surface of the earth. The continual precipitation of rain leads to the escape of a constant supply of latent heat, which acts in the axis like a flue and has a continual "winding-up effect." How far these antagonistic forces balance each other it is impossible to say. They frequently have energy enough to keep under way for two weeks or more, though many die out in a week, and the feeble ones in a few days.

Much condensation is a concomitant of most cyclones,

as might be expected when saturated vapors are exposed to various temperatures and pressures. In a waterspout the hot saturated air of the central shaft is surrounded by the cold spiral of the external air, and condensation results; but the water here is wholly fresh. There is no sucking up of the sea water, appearances notwithstanding.

These tropical cyclones, as has been said before, are not limited to the West Indies, but are found in the doldrums everywhere, especially where there is a mixture of land and water. The author has been in four of these storms—three in the West Indies and one at Apia, Samoa. Two of these were axial. The subjective and objective symptoms are the same in all. The last sunset before the storm has a peculiar look, which can best be described as "oily." There is no mistaking such a sunset when once seen before. These storms last three days, as a rule, at the same point. The circumference is cloud-capped, but the axis is usually clear. An absolute calm exists in the axis, which lasts only for a short time (one hour or more). Here are found mountainous, confused seas, which are very dangerous—more dangerous, in fact, than the winds.

When coming upon indications of an approaching cyclone at sea, the navigator can usually, from the direction of the wind, determine his position relatively to the path of the storm, and lay his course so as to escape as much of it as possible. Since the axis travels at little more than steamship speed on an average, he will usually be successful.

On land these storms cannot be avoided, and should be met by prudent anticipation. Areas of land that have been inundated and are liable to be inundated again should not be built upon. But human nature is much the same, whether in the United States or Porto Rico. When a hurricane revisits any place, it usually finds the same work to do over again.

In recapitulating it will be seen that when the "elements" of a storm have suitable values, it may never recurve, though this is almost always the case. A cyclone has never been known to cross the Equator; the above analysis shows that such a result is impossible. The above laws apply to any storm at any point of the earth's surface. The only difference between a tropical cyclone and other atmospheric disturbances lies simply in the superior energy of the former; and the energy of all is seen to be derived directly from the sun.

In summing up, we see that a "low" is formed by the sun at some point determined by local conditions. Owing to the rotation of the earth on its axis, a whirlwind must result contra-clockwise in the northern hemisphere and clockwise in the southern hemisphere. The energy of the whirlwind will be proportional to the difference of temperature of its parts, as is the case in all heat engines—and a cyclone may be regarded as a heat engine. A cyclone having its own proper rotational velocity, combined with a rotation about the axis of the earth, is a gyroscope simply, and obeys all gyroscopic laws.

It has long been a source of wonderment that the cyclone should move, just as for years it was considered a paradox that when acted upon by gravity the gyroscope should sustain itself and not fall to the ground. Some idea of the force impelling it may be formed by considering the cyclone as a solid wheel revolving about its axis. If all the axles in the world were welded together into one, it would be unable to hold the cyclone to a fixed point.

The independent motion of a gyroscope, acting under the two rotational forces described above, is in a hyperboloid curve, i. e., it is as close an approach to an hyperbola as it is possible to describe on a spherical surface. We may call this curve a "Spherical Hyperboloid."

This independent motion of its own, combined with the revolution of the earth on its axis, gives us the path of the cyclone as traced on the surface of the earth. This path resembles a parabola with its vertex pointing to the west. According to the conditions of the problem, the axis of the spherical paraboloid may deviate somewhat to the northward (or southward) of a strictly east and west line. The detailed analysis of the problem, together with the computation formulæ, would be out of place in any other than a mathematical journal.

THE CRADLE OF THE HUMAN RACE.

BEFORE considering in what region of the earth the human race may probably have had its origin, it is necessary to make a few prefatory observations regarding the variously estimated "antiquity of man."

In the early part of the present century there was, indeed, no possibility of doubt or disagreement on this subject, for did not every educated person know that the world was created in the year 4004 B.C.? More recently, however, while some leaders in our schools of science have reached the conviction that it is probable that mankind came into being about one hundred thousand years ago, others see reason to believe that this is almost as absurd as Archbishop Ussher's quaint chronology, and that there is little or no doubt that the human race has existed on the face of the earth for more than a million or even two million years.

The theory which would limit the duration of man's existence to one hundred thousand years is based mainly on the grounds that no human bones have been discovered anterior to the Quaternary epoch. But Sir Charles Lyell more than twenty years ago pointed out that although many hundred flint implements, including a large number of knives, had been collected in the alluvial sand and gravel in the valley of the Somme, not a single human bone had been found therein. "The absence," he writes, "of all vestige of the bones which belonged to that population by which so many weapons were designed and executed affords a most striking and instructive lesson in regard to the value of negative evidence, when adduced in proof of the non-existence of certain classes of terrestrial animals at given periods of the past."

He also instances the case of the Lake of Haarlem, extending over 45,000 square acres, which the Dutch government, by means of powerful pumps, converted into dry land in the year 1853. "There had been," he observes, "many a shipwreck and many a naval fight in those waters, and hundreds of Dutch and Spanish soldiers and sailors had met there with a watery grave, yet in the deposits which had constituted for three centuries the bed of the great lake no human bones could be found." One or two wrecked Spanish vessels, some arms of the same period, a few coins, and some shells were all that were discovered.

But if this be true of comparatively recent periods, what human bones, we would ask, can we expect to find in the strata of the Miocene epoch, a million years or more before the Great Ice Age had begun its work of destruction?

Sir Charles Lyell further remarks: "Even of those ancient monuments now forming the crust of the earth, which have not been destroyed by rivers and the waves of the sea, or which have escaped being melted by volcanic heat, three-fourths lie submerged beneath the ocean, and are inaccessible to man; while of those which form the dry land a great part are hidden for ever from our observation by mountain masses, thousands of feet thick, piled over them."

Prof. H. Alleyne Nicholson also points out that almost all the fossiliferous rocks have been laid down in water; and it is a necessary result of this that the great majority of fossils are the remains of aquatic animals. "The remains of air-breathing animals, whether of the inhabitants of the land or of the air itself, are comparatively rare as fossils."

It is clear, therefore, that the negative evidence is of little or no value or importance, and must be disregarded in considering the duration of man's existence on the earth. Darwin, it will be remembered, was of opinion that man may have existed in the Eocene period, while Mr. Wallace holds* that he certainly did exist in that period. Prof. Huxley also appears to have held this view, for he observes that the first traces of the primordial stock whence man has proceeded need no longer be sought, by those who entertain any form of the doctrine of progressive development, in the newest Tertiaries, but that they may be looked for in an epoch more distant from the age of the Elephas primigenius (mammoth) than that is from us.

The fact that flint implements of the pre-glacial era are found both in Europe and also in North America clearly proves that man, even at that remote date, had spread from one end of the globe to the other, and must therefore have already existed for many thousands of years. "The remoteness of the date," observes Sir John Evans, "at which the Palæolithic period had its beginning almost transcends our power of imagination;" and Prof. Ratzel in his History of Mankind states that a regular workshop for the manufacture of chert flakes, which was discovered on the banks of the Mississippi in Minnesota, dates from the inter-glacial era, and that hunters chased the long-extinct beasts of the Drift Age in Mexico and in Argentina.

It has been pointed out by more than one writer that man is not the lineal descendant of any of the existing species of apes, and that the divergence of the branch which ends in man from that which includes monkeys and anthropoid apes must have taken place not later than the Eocene or the beginning of the Miocene period.

But how long ago is it since the commencement of the Eocene period?

Lord Kelvin states that, to judge by the properties of rocks and by underground temperature, the date of the solidification of the earth was probably about thirty million years ago. And from the estimated depth of the primary and secondary strata, their formation probably occupied about 26,000,000 years. The date of the beginning of the Eocene period cannot, therefore, be estimated at less than 4,000,000 years from the present time.

And what was the climate or temperature of the earth, of central Europe, and of the polar regions at that date? Sir A. Geikie writes:

"A consideration of the history of the solar system would of itself suggest the inference that on the whole the climate of early geological periods must have been warmer. The sun's heat was greater; probably the amount of it received by the earth was likewise greater, while there would be for some time a sensible influence of the planet's own internal heat upon the general temperature of the whole globe. . . . There appears to have been a gradual lowering of the general temperature during past geological time."

Lord Kelvin observes that the hypothesis that terrestrial temperature was formerly higher, by reason of a hotter sun, is rendered almost infinitely probable by independent physical evidence and mathematical calculation.

But we know that even in the Miocene epoch Europe enjoyed a tropical climate and was about twenty degrees warmer than it is at present. In the polar regions dense forests were to be found where now are only vast fields of ice; and water-lilies are said to have grown within eight degrees of the North Pole. The elephant, hippopotamus, lion, hyena, and rhinoceros were at that time common animals in Europe and Great Britain, although they now live, with the gorilla and chimpanzee, in Africa. The dryopithecus also inhabited France, and this now extinct anthropoid ape is said by M. Lartet and other writers to have more closely resembled man than either the gorilla or the chimpanzee, both of which may also have lived in Europe during this period.

In the Eocene epoch it was even warmer than in the Miocene; and it is a fact respecting which there is no doubt or uncertainty whatever that the ancestors of the human race did exist in the Eocene period, although we do not know whether they were so far advanced as to be properly described as men. Possibly they were not; but in any case we must all agree that at that early date they were, so to speak, "in the cradle." And where was that cradle?

Häckel thinks it may have been in the south of Asia, Wallace in Central Asia, Wagner in Europe, and Darwin in Africa.

If, however, we take into consideration that man deteriorates in a tropical climate, and advances, both physically and mentally, in those countries where the temperature in the hottest season of the year seldom exceeds 70° or 80° F., and if we at the same time remember how great must have been the heat during the Eocene epoch, four million years ago, we shall have no difficulty in perceiving that we must turn to those regions of the North where the temperature at that time would be similar to that of the south of Europe at the present day if we wish to find the most suitable habitat for our early ancestors.

Moreover, if man had been a tropic-bred animal, we should not have found him so far north as Britain, or the valley of the Somme, during the glacial period, when the cold was driving the European flora and fauna into the far South.

If we concentrate our attention on the traces of "prehistoric man" found in the northwest corner of Europe, we are surprised to note their number and importance as compared with those found in other parts of Europe, in Asia, or in Africa. It is not only the flints found in Suffolk, and in almost every part of England (some of which are said to be preglacial), and in Belgium, France, and Germany, but there are also the human remains found in the caves—the Brixham Cave, and Kent's Hole, near Torquay—the Neanderthal skull, found near Düsseldorf; the Spy skeletons, near Namur; the Borreby skulls, in Denmark; the Engis skull, and others too numerous to be mentioned; and when in addition to all this we remember that the dryopithecus was a native of France, we are at first naturally inclined to jump to the conclusion that here, in this northwest portion of Europe, was the cradle of the human race. But unfortunately, so far as this supposition is concerned, we find that belonging to the same remote date, if not to an even earlier period, similar worked flints and other human relics are found in America. Now in order to get from Torquay, or the valley of the Somme, from Namur or Düsseldorf to America, or from America to these places, man must either have crossed by the Behring Straits or by the now submerged route across Iceland and Greenland. And this is a most important fact which we cannot gainsay or disregard. But if this be so, we are compelled to admit that long before the glacial epoch (which is said to have lasted from 240,000 years ago up to about 80,000 years ago) man was in or near the Arctic regions. There is no getting away from this fact. And as the human race was therefore near the polar regions at a time long anterior to that of any of the flints found in Great Britain or in the Somme valley, we are unwillingly compelled to relinquish the hypothesis that the cradle of the race may have been in the northwest of Europe.

If, on the other hand, we turn our attention to the traces of "prehistoric man" in North America, we find that these equal if they do not exceed those of Europe. A large number of them are referred to in an article by Mr. Wallace which appeared in this Review in November, 1887, and among them he mentions that when the great mastodon now in the British Museum was found by Dr. Kock in the Osage Valley, Missouri, a number of stone arrow-heads and charcoal were found near it, and that one of the arrow-heads lay under the thigh bone of the mastodon and in contact with it. This animal, it will be remembered, was found at a depth of twenty feet, under seven alternate layers of loam, gravel, clay, and peat, with a forest of old trees on the surface.

He also refers to the case of the Calaveras skull.

"In the year 1866 [he writes] some miners found in the cement, in close proximity to a petrified oak, a curious rounded mass of earthy and stony material containing bones, which they put on one side, thinking it was a curiosity of some kind. Prof. Wyman, to whom it was given, had great difficulty in removing the cemented gravel and discovering that it was really a human skull nearly entire. Its base was embedded in a conglomerate mass of ferruginous earth, water-worn volcanic pebbles, calcareous tufa, and fragments of bones, and several bones of the human foot and other parts of the skeleton were found wedged into the internal cavity of the skull. Chemical examination showed the bones to be in a fossilized condition, the organic matter and phosphate of lime being replaced by carbonate. It was found beneath four beds of lava, and in the fourth bed of gravel from the surface; and Prof. Whitney, who afterward secured the specimen for the State Geological Museum, has no doubt whatever of its having been found as described."

But although these numerous traces of prehistoric man found in America might lead us to suppose that there was the birthplace of the human race, we are unable to adopt that theory. In that continent there are at the present time no anthropoid apes, and so far as we know there never have been any in past ages. Nevertheless, we can hardly refuse to admit that the evidence clearly shows that our ancestors were in North America during the later portion of the Tertiary epoch, and that they came there from or by the Arctic regions, Behring Straits, or Greenland.

In a letter to the Times newspaper in August, 1897, I pointed out that "science would appear to teach us that our planet was at one time a fiery mass, the heat of which was too great to permit of either animal or vegetable life, and that as this fiery mass cooled down the first parts to reach a temperature sufficiently low to allow life to exist would be the North and South Poles. At these parts evolution would be going on through long ages, and eras of many millions of years, while the tropics were still a fiery girdle round the earth, across which no living creature might pass."

Sir Herbert Maxwell, in his interesting Memoirs of the Month, observes that "birds, drawn by a hereditary impulse, press as far northward as possible to rear their young, bearing witness that in Polar, not in Equatorial regions lies the source of animated nature." And Prof. Miall in his Round the Year points out that "races of men, races of animals, races of plants, religious faiths, modes of civilization, all originate in the Northern Continents and spread out in successive waves. . . . The Palæ-Arctic region, and, in a less degree, North America, have been the officina gentium of which Jornandes spoke, the laboratory in which new tribes are fashioned, the starting point of waves of migration which at length reach to the remotest corners of the earth."

This corresponds in a great measure with my own view on the subject, which is that the cradle of the human race was probably the vast tract of unbroken land lying between the Ural Mountains on the west and the Behring Straits, the Sea of Okhotsk, and Manchuria on the east. It also is partly in accordance with the opinion of Mr. Wallace, who suggests that the birthplace of man was probably in Central Asia; but the region to which we refer more especially lies to the north of Central Asia. It is three thousand miles across from the Ural Mountains to Manchuria, and in

* Nineteenth Century, November, 1887.

so large a country the human race may have multiplied for centuries and have reached more than a million members before it spread to the other continents. This region is little known from a geological point of view, and may contain any number of human relics, fossils, flints, skeletons, etc., for anything that we know to the contrary. During the Eocene epoch the climate and temperature would be similar to that of the south of France at the present time, and would not, therefore, be too hot to allow the race not only to exist but also to progress and improve. As its extreme northern boundary is close to the polar regions, in this respect it also meets the view of those who hold that the source of animated nature was located at the Poles and not at the Equator. Its propinquity to the Behring Straits, where there was probably at that time an isthmus joining the two continents, would enable the race to pass over into America, and would account for the fact that they were apparently in that country at an even earlier date than that at which they reached Western Europe. They would also at once spread into China; and we know from the unique and primeval character of the Chinese language that there is no older race on the earth than the Chinese, and that in China mankind may possibly have first learned to talk and develop the faculty of speech.

In this vast region between Manchuria and the Ural Mountains there are high table lands and other districts that are comparatively destitute of trees, and it is not improbable that primitive man got separated from or driven out of the forest and was compelled to give up tree-climbing and to take to walking on these wild plateaux and prairies. After scrambling along on his "back-hands" or "hind-feet" for a long time, the latter at length would develop the strength and form of the human foot, and would lose the shape and character peculiar to the ape. But this would not take place so long as he was living in woods and was accustomed to use his "back-hands" in clasping boughs and climbing trees to reach the fruit that grew thereon. It would not have taken place if his cradle had been a tropical forest.

Almost opposite Manchuria lies the island where dwell the hairy Ainus, so graphically described by Mr. Landor. Is it possible, we would ask in conclusion, that these closely resemble our early ancestor, prehistoric man?—Samuel Waddington, in the Nineteenth Century.*

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Exposition in Constantinople.—The exposition of American goods and products which was established last year in Constantinople, says Consul-General C. M. Dickinson, of Constantinople, under the name of the American Oriental Agency, is already a success and has outgrown the expectations of those who are conducting the business. They have found their accommodations inadequate, and have recently rented and removed to a large building centrally located on the principal street of the business part of Constantinople.

This change was contemplated and the details arranged before I left my post. The removal has since been made, and, as the business has ample capital and large commercial experience in its management, it ought to prove a pronounced success. Consul Ravndal, of Beirut, writes me of a recent visit to Constantinople, as follows:

I spent three hours with the manager of your American exposition there. It has elegant quarters centrally located and certainly promises great results.

It should be understood, however, that the markets of the East are not waiting for American goods. They are already occupied by the English, German, French, and other nations; and the entering wedge of American commerce is not to be driven into those markets without intelligent, persistent, and vigorous blows. There will be no rush of American products, except in such articles as wire nails, railway materials, rails, and other iron goods in which our prices are clearly below foreign competition. Trade generally must be exploited and built up by the same means and methods used in other localities where the field has been preempted, especially as those who have enjoyed a monopoly of these markets are shrewd enough to be extremely jealous and apprehensive of American rivals.

As there seems to be some misapprehension concerning the aim and scope of this exposition and American Oriental Agency, I beg to offer an explanation as to what it is and what it is not.

It is an exposition, because it carries a large line of samples of American goods of great variety, as well as a stock of staple goods which find ready sale in the Turkish markets. But it is not merely an exposition. It is a business enterprise conducted for profit, with every facility which extensive capital, a knowledge of foreign languages, experience, and brains can employ.

Nor is it a "close corporation." Any American manufacturer who wishes to put his goods on the markets of Turkey, Egypt, Greece, and the Balkans, and southern Russia, can join this enterprise without the payment of a single dollar, and with the assurance that every reasonable effort will be made to find a market for his products. If they are sold, credit is not given to Tom, Dick, or Harry who may be irresponsible, but the exporter deals directly for cash or on credit, as may be agreed, with W. S. Bigelow & Company, of 116 Broad Street, New York, or with the American Oriental Agency, whose proprietor, Mr. L. Zarifi, is one of the leading bankers of Constantinople. Neither he nor Messrs. Bigelow & Company, who represent the American end of the combination, can get any return for their labor and expense except by selling the goods of the parties they represent and making a profit thereon.

This is the only method by which an individual exporter can reach the foreign market, and I maintain it is the only true method. The middleman who connects the exporter with the foreign consumer must be directly interested in selling goods and getting his pay. If he derives compensation in any other way, he is almost certain to relax his efforts. Moreover, in this case the exporter pays, if he pays anything, not for rainbows or promises, but for actual results. By combining large and varied interests, the American Oriental Agency can afford to do what would be impossible for a smaller concern, to wit, canvass the market thoroughly, with the understanding that it is to derive no profit unless sales are actually made.

I beg to add a few words as to the connection of my office with this enterprise. There is not a man connected with it who derives a penny of profit from the business either directly or indirectly. They are all employed and paid by the government, and their interest in this work is due to the fact that it is a part of their business to advance and protect American commerce in every form.

After Barber & Company were induced, early in 1899, to make direct sailings from New York to Constantinople, Smyrna, and other Levantine ports, the necessity of establishing an exposition, agency, or depot to supply American goods was apparent. There were plenty of people anxious to represent American exporters, but most of them are irresponsible or are interested in the sale of foreign goods with which we compete. I made several efforts to interest commercial organizations in the United States in this project, but received no substantial encouragement.

Then I induced Mr. Zarifi to finance the enterprise and become responsible for its credits. It has required hard work and large expense on his part, and also on the part of W. S. Bigelow & Company, but it is now well started; and, conducted as it is with sagacity and energy, I believe it offers the safest and best possible medium for reaching the Mediterranean markets. Branches in some of the principal cities have already been established, and negotiations for others are well advanced. Mr. Zarifi undertakes to cover with thoroughness Turkey, the Balkan States, Egypt, Greece, and southern Russia, and no one who has made inquiry in regard to his responsibility and long business experience in many enterprises has any question as to his ability to make a success of the undertaking. The agency already represents nearly two hundred American exporters, who are leaders in their respective lines, and negotiations are pending with a number of others.

The director and the active manager of the stores at Constantinople have had wide commercial experience in the East, and they and their employes impress me as men of unusual activity and earnestness. I have no hesitation in recommending the enterprise, with the caution I have already intimated—that quick results in general lines of American goods should not be anticipated. It takes time to put American goods on a new market already accustomed to goods of European manufacture, and if Bigelow & Company and Mr. Zarifi are willing to continue their expense and effort and devote all their energies to this project while the introductory and educational process is going on, the exporter should not be impatient if he fails to get immediate results.

Trade Openings in Guatemala.—After a careful investigation among the importers of Guatemala, I find that cheap and flashy articles attract the buyer rather than those more expensive but of quiet coloring, says Consul-General J. C. McNally, of Guatemala. The articles of hose and underwear imported for local use are of the cheapest grade and much inferior to those of American manufacture. There is, in my judgment, a market here for American haberdashery, and I am certain that its introduction in this Republic will develop a good trade in this line of goods. It is quite impossible to find a shirt, collar, or cuff of American make in all Guatemala, and the same may be said of other articles of wearing apparel.

Observation leads me to believe that our cheaper grade of goods is much superior to the cheaper grades introduced into this country from England, France, and Germany. For the past few months, I have endeavored to ascertain the reason for the monopoly of the import trade by England, France, and Germany. I find that all these countries have resident salesmen here, with display rooms in which to show their goods. This affords the dealers an opportunity to select from numberless varieties of fabric and qualities, and by this means cable orders can be sent, and the goods arrive in a reasonably short time. The representatives of the foreign houses usually make their headquarters in this city, having their warehouses stocked to supply the immediate wants of the trade. When business is quiet here, they make trips into Salvador, Honduras, and Costa Rica, carrying with them all necessary samples and supplying from their headquarters at Guatemala City. This resident system is also a protection to their houses, for, if a firm has financial difficulties, they are on the spot to protect their principals and usually get their accounts in money or goods. A recent failure here will demonstrate the advantage of having a resident representative. A house doing a large business liquidated. The foreign agents had previously become acquainted with the financial difficulties of the firm and were able to step in at the right time. I am informed that the foreign houses were fully protected, while the American creditors had to take what was left. These acquired advantages must, of course, influence the trade, and if our manufacturers desire to compete, they must adopt this system. I reiterate that a general display room for United States goods in all these Central American countries would bring to us the bulk of the trade now being monopolized by European houses.

There seems to be an opening here for American shoes, and I think a good market awaits them. The ready-made shoes are imported principally from France and Germany, and are of a style and quality much inferior to our products at the same price. Shoes made to order have in them a poor quality of leather. The leather is imported from Germany and England. The sole leather is made here, although some shoemakers prefer the Nicaragua sole leather, and much is imported from that Republic.

I am informed that the Pacific Navigation Company has under consideration the idea of extending its steamship line to San Francisco; this will open trade communication direct between San Francisco and the ports of Chile and Ecuador.

A little study of the demands of the trade on the part of the American manufacturer, and a desire to meet the conditions to insure a safe delivery of goods, will win this market for American products.

Raisins and Other Fruit in Malaga.—There is a considerable shortage in the Malaga raisin crop. Up to the 15th of September, there was abundant promise of a full crop; but on that night, a great storm of rain and wind swept over the vineyards of the famous Malaga raisin district, doing great damage, not only to the grapes still on the vines, but to those that had been cut and were being dried into raisins. This heavy storm was unfortunately followed by a succession of cloudy and rainy days, which made it impossible for the grapes to dry properly, and, in consequence, a considerable percentage of the crop already cut for raisins was ruined.

In addition to this, large quantities of grapes still on the vines became worthless for raisins, on account of the damp, and were sent to the wine press.

Up to this moment it is estimated that the raisin crop is short fully 30 per cent. If there should be a recurrence of rainy and cloudy days, the shortage would reach at least 50 per cent. of the average crop. Meanwhile, some of the merchants here who sold raisins on the basis of August and September prices have sustained heavy losses. It is reported that one German ship which was to have carried $250,000 worth of raisins from Malaga to Hamburg and other German ports on the 1st of October, left almost empty. It is also reported, in this connection, that in several instances firms that had taken orders in August and September not only cannot fill them, but are not making good the losses to their clients in Germany and elsewhere. Other firms, unable to make delivery, have manfully paid $1 a box dead loss to their disappointed customers. The principal losses have been sustained in the so-called Malaga seedless raisins. There was a heavy demand for these goods because of the failure of the currant crop in Greece, and now, because of the short crop here, the prices have advanced 100 per cent. during the past thirty days.

Finest cluster raisins are worth 25 pesetas ($4.82) the box of 22 pounds, as against 20 pesetas ($3.96) at the same period last year; second-grade clusters are worth 22·50 pesetas ($4.34) the box, as against 18·50 ($3.67) last year; and the finest loose raisins, 17·50 pesetas ($3.38) as against 12·50 pesetas ($2.41) last year.

There are good reports of the Malaga almond crop. It is full and fine, but owing to the failure of this crop elsewhere in Spain, as well as in France and Italy, prices have advanced from 80 to 100 per cent.

The lemon crop is 15 per cent. less than last year, and the lemons are small; prices are 10 per cent. higher.—Benjamin H. Ridgely, Consul at Malagh.

Hints to Exporters of Ceramics.—A German journal states in regard to ceramic articles that in Smyrna, French and German ware has almost entirely replaced English ware, owing to the lower price of the former. The imports of ceramics at Smyrna are stated to amount to about $50,000 per annum, of which only one-tenth is from the factories of Staffordshire, the greater part coming from Saargemund, Germany, and from Belgium.

According to a British report on the importation of earthenware into the Canary Isles, the demand during the year 1899 was considerably greater than in former years. France supplies the greater part, although Great Britain and Germany have their share of the trade. In glassware, the cheaper kinds are preferred to the expensive English ware, and Germany has secured the largest share of this trade, notwithstanding keen competition from Belgium. During the year 1899, five times as much window glass was imported into the Canary Isles as in the previous year, the greater part of the supply coming from France and Belgium.

In Brazil, according to another report, half-porcelain ware finds the readiest sale; German and Belgian ware is preferred, owing to its pleasing appearance.

According to a French report, it would seem that a good export business to Persia in all kinds of glass and porcelean ware could be cultivated. Fancy glass articles come chiefly from Baccarat, whereas the cheaper articles, such as drinking glasses, are imported from Bohemia. Window glass and lamp chimneys are chiefly of Russian origin. Although glass is manufactured in Persia, it is of very inferior quality and not adapted for general use.

The largest import houses in Teheran, Persia, are agents of Messrs. Ziegler & Company, of Manchester; Messrs. Graeneweg, Dunlop & Company, of Amsterdam, Holland; and the Persian Gulf Trading Company, of London, England.—Walter Schumann, Consul at Mayence.

Tamatave Property Tax.—Consul Gibbs sends from Tamatave, September 2, 1900, copy of a decree changing the property tax on the tenantable value of houses at Tamatave. The alteration is due to the situation in which Tamatave has been placed on account of the recent epidemics of the plague. "The new decree," says Mr. Gibbs, "is essentially the same as the former one, except that the tenantable value is reduced 25 per cent. instead of one-sixth, as formerly." The tax will be 5 per cent. of this value.

British Inquiry for Steel.—Consul Marshal Halstead writes from Birmingham, October 18, 1900, that he is in receipt of a communication from a steel manufacturing company which contains an inquiry for American steel for making forks (hay, pigging, coke, etc.), Siemens or Bessemer process, and requests the names of firms manufacturing high carbon steel of this sort.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 890. November 19.—New Dredger Built in Great Britain—Tunnel from Gibraltar to Morocco—Harvesting Machines in India—Special Consular Reports in Germany.

No. 891. November 20.—Coal in Barcelona: Steamship Line to New York—Jute Crop of India in 1900.

No. 892. November 21.—*Labor Legislation in New Zealand—Quinine Auction in Batavia—Equivalence of Gold and Silver Money in Peru.

No. 893. November 22.—Quartz Mining in Sarcia, Central Siberia—Proposed Abolition of Sugar Bounties.

No. 894. November 23.—*American Meat in South Africa—*Freight Rates from New York to Australia—*Rise in Coal Prices in Australia—*American Coal for Russia—*Fruit Exports from Honduras.

No. 895. November 24.—British Improvements in Knitting Machines—Dry Goods in Guatemala—Russian Freight Rates on German Iron—Coffee Shipments from Guatemala.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

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TRADE NOTES AND RECEIPTS.

Whitewash for Wood or Stone.—For the preparation of a good whitewash for wood or stone, proceed as follows: Slake 20 liters of burnt lime in a suitable vessel, with enough hot water that the latter reaches about 15 centimeters above the lime. Dilute the lime milk thus obtained and add first 1 kilo of zinc sulphate and next ¼ kilo of cooking salt. The latter causes the whitewash to harden without cracks. If desired, the mass may be given a pretty cream color by adding 1½ kilo of yellow ocher or a pearl-gray shade by adding a little lampblack. Fawn color is obtained by 2 kilos of umber and ½ kilo of lampblack, and a stone shade by 2 kilos of umber and 1 kilo of lampblack. The coating is applied as usual with the brush.—Austrian Lack und Farben Zeitung.

Practical Experience in Fireproofing Wood.—According to the Reports of the k. k. Gewerbemuseum, at Vienna, and concurring with the investigations of A. Patera, the impregnation of timber with water glass is useful only if the preparation and composition of the soluble glass had been a correct one, otherwise there will be efflorescences of soda, and the solution does not enter the wood readily.

Impregnating agents which contain an incombustible and insolubie body alongside of water glass, like that of Dorn, containing about 30 per cent. of water, 15 per cent. of sodium silicate, and 55 per cent. of clay, asbestos, and barium sulphate, give a coating which scales off and renders the wood brittle, and can, therefore, not be recommended as a general thing.

The solution recommended by the firm of Fr. Konrad's Nachfolger near Dresden, of bitter salt 5·5 per cent. and magnesium chloride 0·5 per cent. on the one hand and borax 5 per cent. and boracic acid 0·5 per cent. on the other, which are employed in rotation, did not furnish especially favorable results. Similar results are yielded by an aqueous solution containing 4 per cent. of borax and 3 per cent. of bitter salt. Stronger solutions of more certain action, containing 8·8 per cent. of bitter salt and 12 per cent. of borax, present the drawback of small crystals separating out in the solution as well as in the coating.

Very useful were found to be impregnants like the following: Ammonium sulphate, 70 grammes; borax, 50 grammes; glue, 1 gramme; and water up to 1,000 grammes.

Of like favorable action are solutions of glue, 5 grammes; zinc chloride, 2 grammes; sal ammoniac, 80 grammes; borax, 57 grammes; and water to 700 grammes.

If the coating is to be made visible by coloration, an addition of 10 grammes of Cassel brown and 6 grammes of soda per liter is recommended, which may be dissolved separately in a portion of the water used.

Vinaigre Aromatique.—

Tincture of benzoin	1	liter.
Tincture of storax	2	"
Alcohol, 85 per cent	3	"
Strong vinegar	1·5	"
Acetic acid	50	centiliters.
Tincture of orris root	1	liter.
Clove oil	2	grammes.
Neroli oil	2	"
Rose water	1	liter.
Tincture of tolu	1	"
Mace oil	1	gramme.
Cinnamon oil	2	"

Mix all and filter.

Vinaigre Aromatique de J. V. Bully.—

Alcohol	11	liters.
Lemon spirit	50	centiliters.
Oil of lavender	5	grammes.
Oil of rosemary	25	"
Portugallo oil	12	"
Bergamot oil	30	"
Clove oil	10	"
Neroli oil	4	"
Lemon oil	30	"
Vinegar	125	"
Tincture of benzoin	60	"
Tincture of storax	60	"
Tincture of tolu	60	"
Acetic acid	90	"

Eau de Hebé (Freckle Water).—

Distilled vinegar	660	grammes.
Lemons, cut in small pieces	135	"
Alcohol, 85 per cent	88	"
Lavender oil	20	"
Water	88	"
Citron oil	6	"

This mixture is allowed to stand for three or four days in the sun and filtered. Coat by means of a sponge before retiring the places of the skin where the freckles are and allow to dry.

Liquid Steam Glue.—Pour 50 kilos of warm (not hot) water over 50 kilos of Cologne glue and allow to soak over night. Next day the swelled glue is dissolved with moderate heat, and if still too thick, a little more water is added.

When this is done, add 2·5 to 3 kilos of crude nitric acid, stir well, and fill the liquid glue in well corked bottles.

Original receipts of Alwin Engelhardt in Neueste Erfindungen und Erfahrungen.

Cleaning Gilded and Polychromed Work on Altars.—To clean bright gold, a fine little sponge is used which is moistened but lightly with tartaric acid and passed over the gilding. Next go with a small sponge saturated with alcohol over the gilt work, whereby all dirt is removed. For matt gilding, take only soaper's lye, dip white flannel into it and carefully wipe off the dead gold with this, drying next with a fine linen rag. To clean polychromed work of dirt, etc., prepare a lye of rain water, 1 liter, and calcined potash, 68 grammes. Dip a sponge into this and wash off the article with it, but the object has to be washed again, right after, with a clean sponge and water, so that the lye does not attack the paint too much.—Farben- und Lack Zeitung, Vienna.

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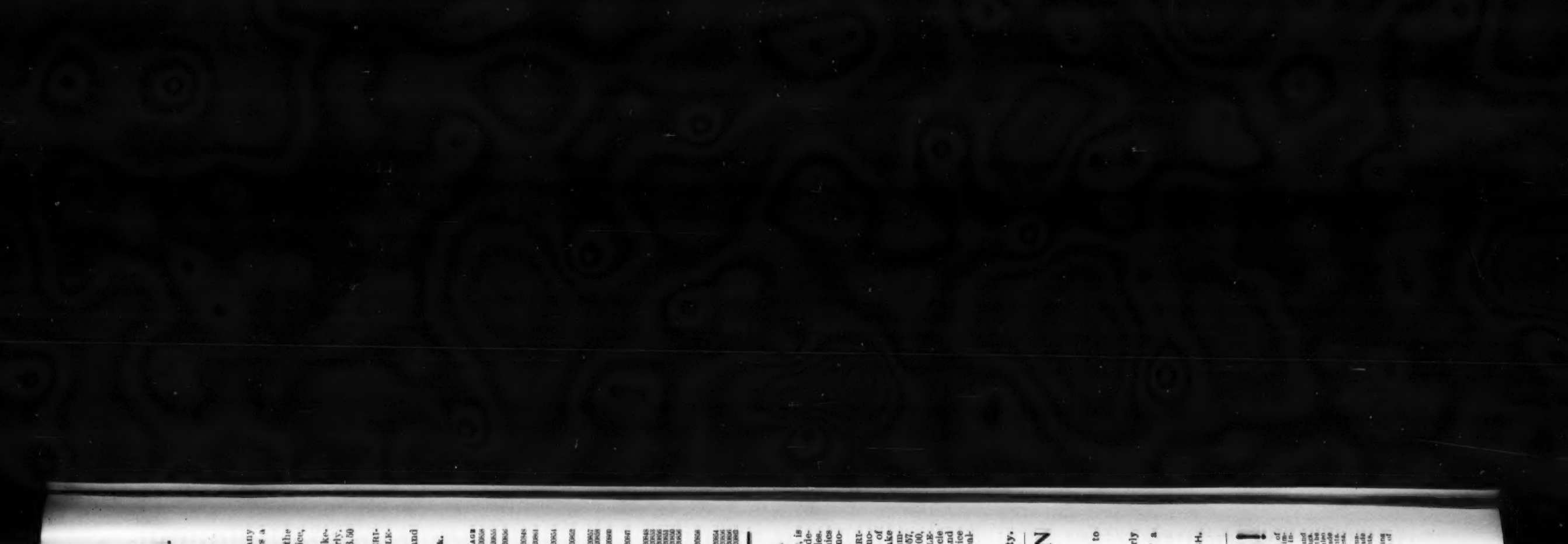
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